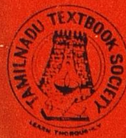
SCIENCE

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STANDARD VII

Untouchability is a sin

Untouchability is a crime

Untouchability is inhuman



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MADRAS

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Part I. PHYSICS

I. MECHANICS

I. MEASUREMENT

1. Measurement of Long Distances

Measuring tapes are used to measure length. Your physical educational teacher uses two different kinds of tapes. One is for measuring your chest and the other is for finding the distances you have covered in long jump or shot put. The former is being used by tailors also. It is of one centimetre width and one metre length, and is made of thick cloth. Tapes used for measuring long distances, are 1 cm. wide and are available in 2 m., 25 m., and 50 m. lengths. These tapes are made of steel or polythene. The tape is kept in a disc box to facilitate easy manipulation. A metallic ring is found in the outer end of the tape. The tapes are marked in centimetres and millimetres. The metre markings are made in a different colour.

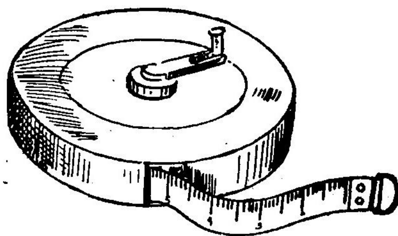


Fig. 1
Disc Box Tape

Two persons are required to measure long distances. One holds the metallic end of the tape at the starting point and the other draws the tape out of the box and stretches it along the distance. When the entire length of the tape is drawn out, a mark is made where the other end touches the ground. Now, the first person holds the metallic end of the mark while the second person moves along the same direction repeating the process, till the entire distance is covered.

The number of times covered by the whole length of the tape and the balance in metres and centimetres are found out. The total length is calculated by adding the two. For instance, the distance covered by the discus thrown, is measured by a 25 m. tape. The whole length of the tape is taken thrice and the balance is 11 m. 60 cm.

Hence the total distance $= (25 \times 3) + 11\text{m. } 60 \text{ cm.}$

$= 75 + 11{\cdot}6 \text{ m.}$

$= 86{\cdot}6 \text{ m.}$

2. To measure the Area of an Irregular Lamina

The area of regular geometrical figures like the square, the rectangle and the circle are found using the respective formula. The area of an irregular lamina is found using a graph paper.

A graph paper is taken. The irregular lamina, whose area is to be found out, is placed on the graph paper and an outline of the edges is drawn closely. Count the number of full centimetre squares. While

counting the millimetre squares, the half squares and more than half squares are taken as full and if less than half, they are not counted. For instance, if 21 centimetre squares and 786 millimetre squares are contained in a figure, the area is calculated as follows:

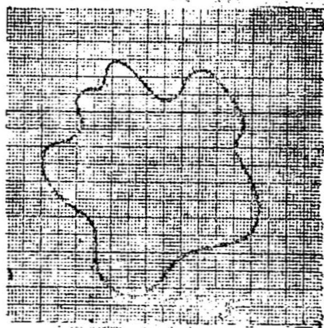


Fig. 2
Area of Irregular Body

The area of 21 cm. squares $= 21 \text{ cm}^2$

The area of 786 mm. squares $= 7{\cdot}86 \text{ cm}^2$

$$\left(\frac{786}{100} = 7{\cdot}86\right)$$

$\therefore$ Area of the irregular lamina $= 28{\cdot}86 \text{ cm}^2$

3. Drawing a Figure to scale

If we want to draw a plan of your class room or school on a paper, with the same dimensions paper of the same size will be required. To think of this itself is ridiculous. Drawing the figure, reducing the size but not the shape, is known as drawing to scale. You can see maps of three different sizes in your class—maps in your text book, maps used in examinations and wall maps.

You can draw the plan of your class room, a rectangle 20 m. long and 8 m. wide, by drawing a

rectangle 10 cm. long and 4 cm. wide in your note book. Then the scale will be 1 cm. = 2 m. The same figure can be drawn to different scales and it will be seen that the figures are similar and of

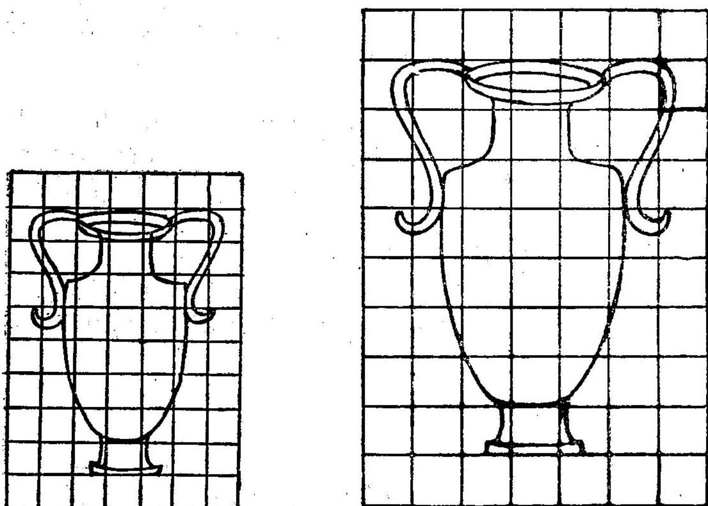


Fig. 3

Enlarging a Figure to scale

different sizes. Figures in your History book, Geography book or Atlas are drawn similarly. The scale taken will be marked in the map itself. If it is marked as 1 cm. = 250 km., then the actual distance of two places 1 cm. apart in the map is 250 km. Any part of 1 sq. cm. area will be actually 250 km. × 250 km. = 62.500 sq.km. Two places 3·6 cm. apart are actually 900 cm. apart. An area of 1,87,500 km^2 is shown by an area of 3 cm^2 How?

Exercise

1. Questions

1. Describe a disc box-tape.
2. How will you measure a length like that covered by javelin throw or cricket ball throw?
3. The length of a play ground, while measured with a 25 m. tape, covers 8 times the full length of the tape and 18 metres. Find the length of the play ground.
4. Describe the method of finding the area of an irregular figure using a graph paper.
5. What is drawing to scale?

II. Do it yourself

1. Measure the length and breadth of your class room.
2. Draw the plan of your class room to scale after measuring its length and breadth.
3. Measure the distance between two important places, in the map, either in the atlas or your text book, and find the actual distance using the scale given there.
4. Draw the plan of your living room or your house to scale.
5. Paste an outline map of India, with states marked in it, on a card board., Prepare cut-outs of the states. Place each one of them on a graph paper and find the area.

6. Prepare a tabular column as suggested containing the name and area of the states of India.

Sl. No.	State	Area in km^2.
1.	Tamilnadu	
2.	Kerala	
3.	Jammu Kashmir	
4.	Bihar	

III. Pay a visit to

1. the district or taluk headquarters office and see the map of the district or taluk.
2. the district or divisional sports meet and see how the distances are measured.
3. the stalls in an exhibition, showing maps and models of dams, projects etc.

2. FINDING THE VOLUME

You have already learnt the use of the overflow jar and the measuring jar in finding the volume of objects. In this lesson, we will learn about a few other vessels for measuring volumes.

1. The Measuring Flask

This is a flat bottomed glass vessel as shown in Fig. 4. The neck of the flask is narrow and long.

There is a circular mark around the neck of the flask. The capacity of the flask is marked on it. If the flask is filled upto the mark with a liquid, the volume of the liquid is the same as marked on it. Measuring flasks are available normally in the following capacities—in multiples of 5 ml. 10 ml., etc. and in multiples of 50, like 100 ml., 250 ml. etc.

The measuring flask is used for measuring a fixed volume of any liquid. The following points are to be noted while using the measuring flask:

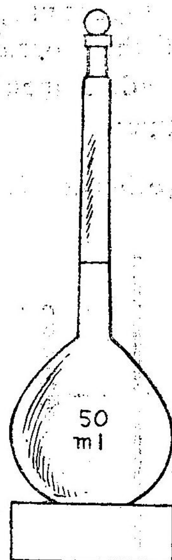


Fig. 4
Measuring Flask

(i) The flask must be kept on a horizontal plane.

(ii) The lower meniscus of the liquid should coincide with the mark on the neck (this can be ensured by placing a white paper behind the neck).

(iii) The meniscus must be viewed horizontally avoiding parallax error.

2. The Burette

It is a cylindrical glass tube with a narrow cross section which ends in a nozzle. Graduations are made on the glass from top to bottom from 0 to 50 ml. Each millilitre is divided into 10 equal parts, enabling measurement of volume correct to 0·1 ml.

accurately. Just above the nozzle, there is a stopper with a small hole in it. The flow of the liquid from the burette can be controlled by turning the stopper properly connecting the hole of the stopper and the nozzle. If a rubber tubing is connected instead, a metal pinch-cock is used in place of the stopper.

Experiment 1.

Aim: To draw out a particular quantity of the given liquid using the burette.

Apparatus required: burette, stand, flask with the given liquid, an empty beaker.

Procedure: The burette is rinsed first with water and then with the given liquid. The stopper is closed and the burette is fixed vertically to a stand. The given liquid is poured into the burette till the water level is well above the '0' mark. Then the liquid level is brought to coincide with the '0' mark by controlled flow of the liquid through the nozzle, turning the stopper properly. The stopper is

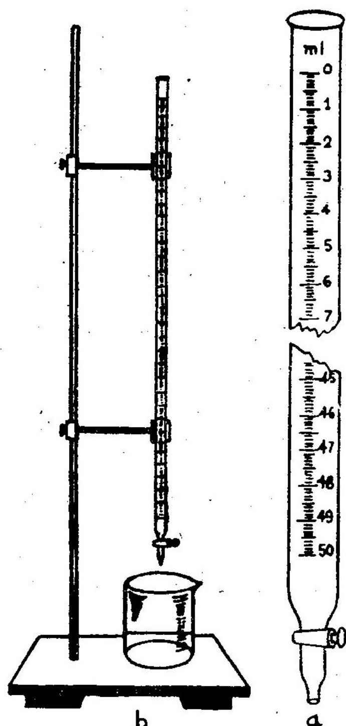


Fig. 5

a. Burette

b. Burette with Stand

then closed. An empty dry beaker is placed under the burette and the stopper is completely opened. The liquid is allowed to be drained freely till almost the required volume is collected in the beaker. Then the stopper is turned so that the liquid is drained in drops and it is closed when the required volume is collected in the beaker.

Experiment 2.

Aim: To find the average volume of a lead shot using the burette.

Apparatus required: burette, stand, flask with water, lead shots.

Procedure: The burette is rinsed with water and then fixed vertically to a stand. It is then filled with water to a particular level and the level is noted down. Parallax error must be avoided while noting the levels. Air bubbles must be removed by slightly shaking the burette. 20 lead shots of almost the same size are taken and are dropped one by one gently into the burette. Water should not splash out and no air bubble be allowed to collect between these shots, by tapping the burette gently. The final level of water is noted down. Similarly another set of 20 shots are dropped and the level noted. A set of 5 such experiments is repeated using 100 shots.

The readings are recorded in the following table :

Expt. No. (1)	No. of lead shots dropped in (2)	Initial level of water (3)	Final level of water (4)	Vol. of 20 lead shots (3)—(4) (5)	Vol. of each lead shot $\frac{(3)-(4)}{20}$ (6)
		(ml.)	(ml.)	(ml.)	(ml.)
1	20	25	24·7	0·3	0·015
2	40(-20)	24·7	24·4	0·3	0·015
3	60(-40)	24·4	24·1	0·3	0·015
4	80(-60)	24·1	23·8	0·3	0·015
5	100(-80)	23·8	23·5	0·3	0·015

The average volume of one lead shot $= \frac{\text{The total of (6)}}{5}$

$$= \frac{0{\cdot}075}{5} = 0{\cdot}015 \text{ ml.}$$

The same experiment can be repeated using 100 similar lead shots of different sizes.

3. The Pipette: This is used for taking a small fixed quantity of a liquid from a bulk quantity. This is a long glass tube, open at both ends. The cross section is large in the middle and narrow on both sides. One end is drawn into a nozzle. The volume of liquid that could be taken out by the pipette is marked on the middle. Generally they are avail-

able in 5 ml., 10 ml. and other similar volumes. There is a mark in the tube above the middle section.

Experiments

Aim: To take out a particular quantity of the given liquid using the pipette.

Apparatus required: pipette, given liquid in a vessel, empty beaker.

Procedure: The nozzle end of the pipette is put in the liquid and air is sucked from the other end. The liquid rises into the pipette. It is carefully drawn till the liquid level is a little above the mark and the top end is closed with the index finger. The pipette is taken out and the liquid level is brought to coincide with the mark by carefully releasing the index finger. Now the pipette is taken above the beaker or any vessel to which the particular quantity of the liquid is to be transferred. The index finger is released completely and the liquid pours into the vessel. Thus we get a particular quantity of the liquid, into the vessel. The last drop of liquid sticking to the nozzle must not be blown out. Care is to be taken not to suck the liquid into the mouth.



Fig. 6
Pipette

Exercise

I. Questions

1. Name some of the vessels used for measuring liquids.

2. Draw a diagram of a pipette and explain how it is used.

3. Draw a diagram of a burette and explain how a particular quantity of the given liquid is taken out by it

4. Describe the method of finding the average volume of a lead shot using a burette.

5. A burette contains 12·6 ml. of water. When 20 lead shots are dropped into it, the level rises to 12·2. Find the average volume of a lead shot.

II. Do it yourself

1. Find the average volume of a pin with the help of a burette using 40 pins.

III. Pay a visit to

1. the bio-chemistry laboratory in the hospital

2. the analytical laboratory in factories manufacturing cement, drugs etc.

IV. Find out why

1. the graduations in the burette are from top to bottom.

2. when the index finger closes one end of the pipette, the liquid contained in it does not come out of the other end.

3. THE WEIGHT OF A BODY

The force with which a body is attracted towards the centre of the earth is known as the weight of the body. As the mass of the body increases, its weight also increases. Have you seen weighing charcoal or firewood in cart loads? The instrument used is the spring balance.

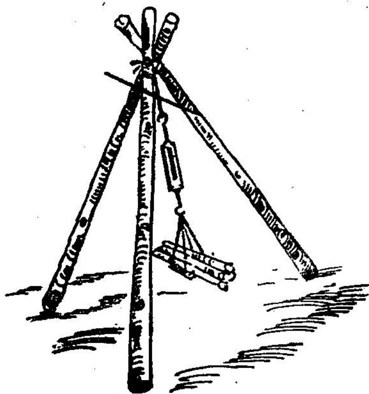
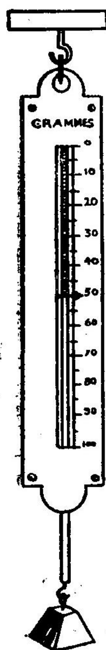


Fig. 7
Weighing Firewood by a Spring Balance



1. The Spring Balance

A spring is placed at the centre of the grove in a wooden piece or in the hollow half of a long cylinder. A ring is attached to the upper end and a hook to the lower end of the spring. The spring has a pointer attached to it and the pointer moves along a slot in a graduated metal plate. The spring is kept behind the metal plate. The pointer shows the exact weight of the body. It is read by the mark on the metal plate. No weight need be put in a spring balance to find out the weight

Fig 8.
Spring Balance

of a body. This should not be used to weigh articles heavier than it is intended to weigh. The spring will lose its elasticity

2. The Common Balance

The common balance is used in grocery shops and vegetable markets. A pointer attached

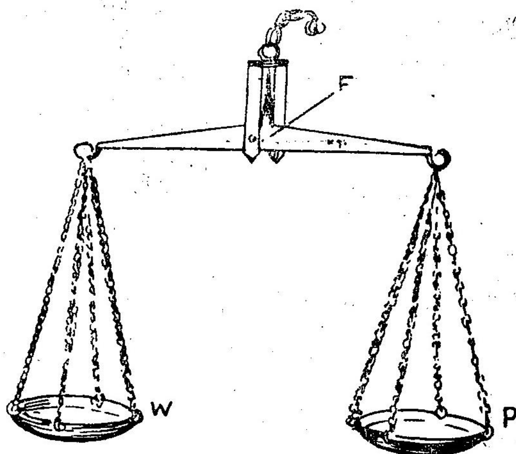


Fig. 9
Common Balance

to the centre (*F*) of a horizontal beam, oscillates within a metallic frame, also attached to the centre of the beam. Two pans of equal weight are attached to the ends of the beam equidistant from the centre. The metallic frame can be held by a hook or a ring attached to it.

Before finding the mass of a body, the balance is held up when the pans are empty. The upright pointer should be at the centre of the metallic frame.

and the beam should be horizontal, thus ensuring the equal weight of the pans. The weight required (W) is put on the left pan and the body to be weighed on the right pan. The balance is held up by the hook. The quantity of the object on the right pan is adjusted so that the pointer is in the central position. Now the weight of the body is equal to the weight put on the left pan.

Normally a balance weighs bodies from 1 gm. and more. Bullion balance weighs even upto 1 milligram (mg.)

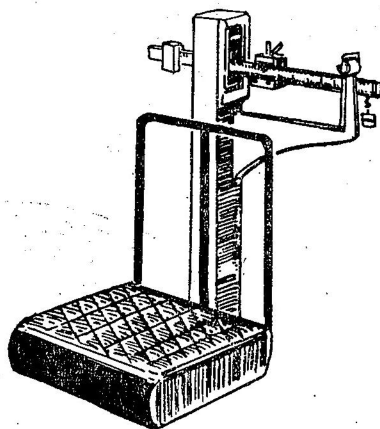


Fig. 10

Balance in Paddy Market

Spring balances are available in other shapes also. They can be seen in post offices and paddy markets.

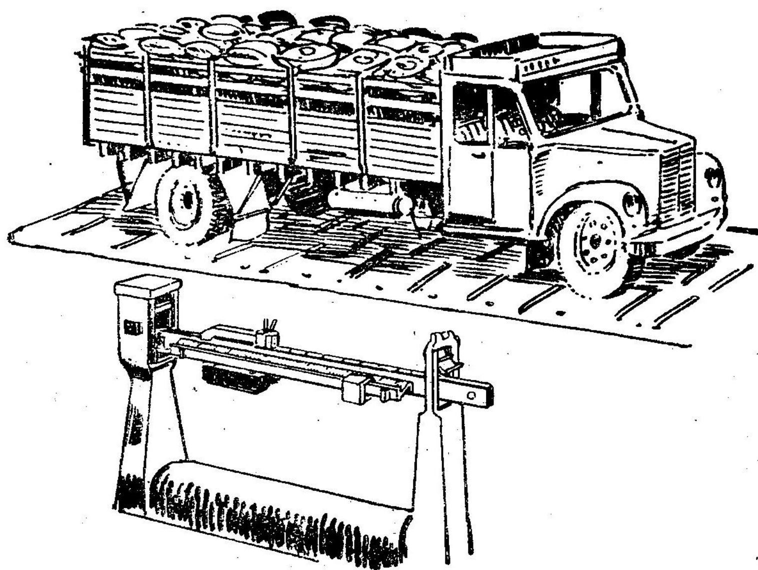


Fig. 11
Weigh Bridge

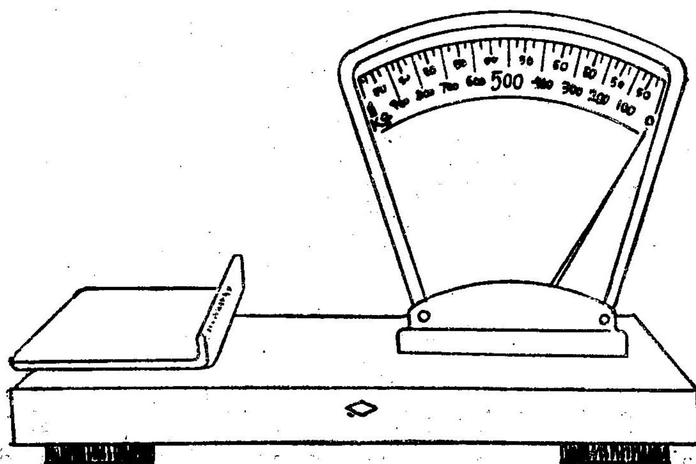


Fig. 12
One type of Spring Balance

Exercise

I. Questions

1. Describe a spring balance.
2. How is the weight of a body found with the help of a spring balance?
3. Describe a common balance?
4. How would you weigh the mass of a substance with a common balance?

II. Do it yourself

1. Construct a spring balance with a long piece of rubber band, a scale and weights and find the weight of a body.
2. Construct a common balance with two hemispherical peels of an orange or a lime fruit or two identical, hemispherical coconut shells, twine, weights and a scale.

III. Pay a visit to

1. the goods yard or parcel office in a railway station.
2. the registration counter in a post office.
3. the paddy market in a village.
4. Super market, India Coffee House or any Coffee seeds shop.
5. The weigh-bridge where the load in a lorry is weighed.

IV. Do you know why

1. In a common balance the weight is put on the left pan and the object on the right pan.

4. THE DENSITY OF A SUBSTANCE

Take equal volumes of iron, aluminium, and pith pieces. Find the mass of each of them. The mass of the iron piece is greater than

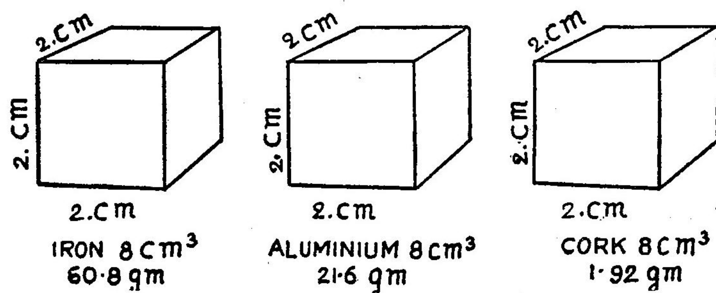


Fig. 13

Things with equal volumes have different masses

that of the aluminium piece which is greater than that of pith. Take pieces of equal masses of the above substances and find their volumes. The volume of iron is the least and that of pith is the largest. This is because the atoms of iron are densely packed. But the atoms of aluminium and pith are loosely packed. In the liquid state, the mass of 1 ml. or 1 cc. of water is much less than

that of 1 cc. of mercury. **The ratio of the mass of a substance to its volume is known as its density.**

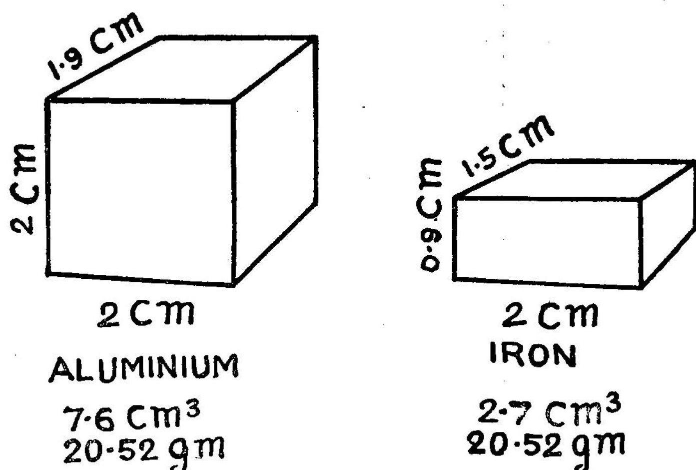


Fig. 14
Equal mass but different volumes

In other words the mass of 1 cc. of the substance is its density. **The density of any substance is the mass of unit volume of that substance.**

The densities of some solids and liquids are given below:

Solids	Density gm./cm³	Liquids	Density gm./cm³
Gold	19·3	Mercury	13·6
Silver	10·5	Sea Water	1·025
Iron	7·6	Pure Water	1·0

Solids	Density gm./cm³	Liquids	Density gm./cm³
Aluminium	2·7	Methyl alcohol	0·791
Crown Glass	2·6	Paraffin Oil	0·8
Wood	0·9	Gingelly Oil	0·92
Pith	0·24	Coconut Oil	0·91
		Kerosene	0·83
		Petrol	0·7

Density is denoted by the letter d. Similarly Mass is denoted by m and volume by v.

If the mass of a substance is m gm. and the volume is v cm³., then its density $d = \frac{m}{v}$ gm./cm³. *i.e.* the mass of 1 cm³. of the substance. Therefore,

$$\text{density} = \frac{\text{mass of the substance}}{\text{volume of the substance}}$$

similarly $v = \frac{m}{d}$ (volume = mass/density)

and $m = d \times v$ (mass = density × volume)

Worked Examples

(1) 7 cm. of silver weighs 73·5 gm. Find the density of silver.

$$d = \frac{m}{v} = \frac{73{\cdot}5}{7} = 10{\cdot}5 \text{ gm/cm}^3$$

(*i.e.*)

The mass of 7 cm^3. of silver is 73·5 gm.

The mass of 1 cm^3. $= \frac{73 \cdot 5}{7} = 10 \cdot 5$ gm.

$\therefore$ The density of silver $= 10 \cdot 5$ gm/cm^3.

(2) The mass of a piece of gold is 193 gm. Find its volume using the table of densities given.

$$v = \frac{m}{d} = \frac{193}{19 \cdot 3} = 10 \text{ cm}^3.$$

(*i.e.*) The density of gold, as per table is 19·3 gms/cm^3.
volume = mass/density

$$= \frac{193}{19 \cdot 3} = \frac{1930}{193} = 10 \text{ cm}^3.$$

Finding the Density of Solids

1. Regular Geometrical Solids

The volume of regular solids are found by the respective formula. Find its mass. Using the formula $d = m/v$, the density can be calculated. The formulae for finding volumes are given below:

Cube (side 'a') $= a \times a \times a = a^3$ cubic units

Cuboid (length l, breadth b, height h)

$= l \times b \times h = lbh$ cubic units

Cylinder (radius r, height h) $= \pi \times r \times r \times h$

$= \pi r^2 h$ cubic units

Sphere (radius r) $= \frac{4}{3} \times \pi \times r \times r \times r = \frac{4}{3} \pi r^3$

cubic units

2. Irregular Solids

There is no formula for finding the volume of irregular solids. So, the volume is found by using a overflow jar or a measuring flask. Find the mass of the solid. Divide the mass of the solid by its volume. We get the density.

Finding the Density of a Liquid

Take a clean dry beaker and find its mass. (*a* gm.) Take 30 cc. of the given liquid by a burette or pipette and pour it in the beaker. Find the total mass of the beaker and the liquid (*b* gm). Hence the mass of the liquid is $(b-a)$ gm. The mass of the liquid taken is $(b-a)$ gm.

Hence the density $= \dfrac{b-a}{30}$ gm / cm^3

For instance

Mass of the vessel = 42 gm.

Mass of the vessel + 30 cm^3. of paraffin oil = 66 gm.

Mass of the paraffin oil taken (30 cm^3) = 66—42 = 24 gm.

Mass of 1 cm^3. of paraffin oil $= \dfrac{24}{30}$ gm.

Density of paraffin oil = 0·8 gm/cm^3

What would be the total mass of petrol and the vessel, if petrol is taken instead of paraffin oil?

Exercise

I. Questions

1. Define density.
2. What is the meaning of saying that the density of mercury is 13·6 gm./cc?
3. Describe an experiment to find the volume of an irregular solid.
4. How would you find the density of kerosene?
5. The mass of a glass stopper is 19·5 gm. It displaces 7·5 ml. of water. Calculate its density.
6. The radius of a wooden cylinder is 3·5 cm. height 4 cm. The density of wood is 0·9 gm./cm^3. Find the mass of the cylinder.
7. Find the mass of 8 cm^3. of each of the substance noted in the table in pages 19 and 20.

II. Do it yourself

1. Take different objects made of the same material and find the density of each of them. What do you find?
2. Find the length, breadth, and height of a hollow cuboid. Find also its volume. Fill it up with water. Calculate the mass of water without weighing it.
3. Take an empty tin can. Weigh it. Fill it up with the kerosene you have bought from

the shop. Again weigh it. Find out whether you have the correct volume of kerosene as in the bill. (Density of kerosene is 0·8 gm./cm³.

clue: (volume = $\dfrac{\text{(mass of can + kerosene)} - \text{(mass of empty can)}}{0.8}$

4. Take a (tall) jar as shown in Fig. 15 and fill it up with small quantities of mercury, carbon-tetra-chloride, water and kerosene. Slowly drop pieces each of iron, moth ball,

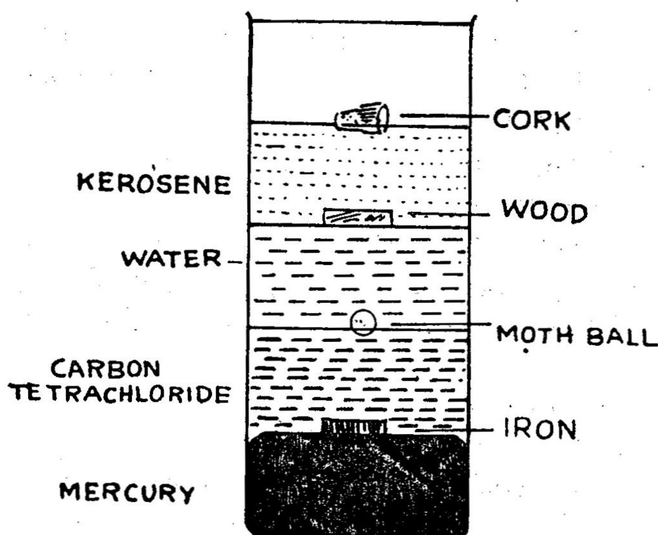


Fig. 15

Bodies of different densities floating on different liquids

wood and cork into the jar. Observe the position of each article. Why do they float at different levels?

III. Do you know why

1. mercury is used in the barometer?
2. ice bergs big enough to break a ship float in the ocean?

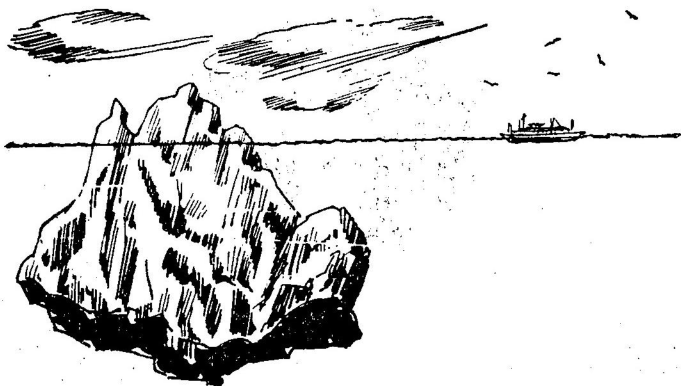


Fig. 16

Iceberg

3. the difference in density of solutions is necessary for the growth of a plant?
4. water is poured in the car battery when it is charged?

5. SIMPLE MACHINES

The "Vimanam" of the Big Temple of Tanjore is made of a single granite boulder. Do you know how it was taken up? A scaffold was built from Sarapallam, a village 20 km. away from Tanjore. We see scaffolds in the construction of new buildings and on religious

occasions like **Kumbabishekam.** The stones were taken in this way to build the Pyramids of Egypt.

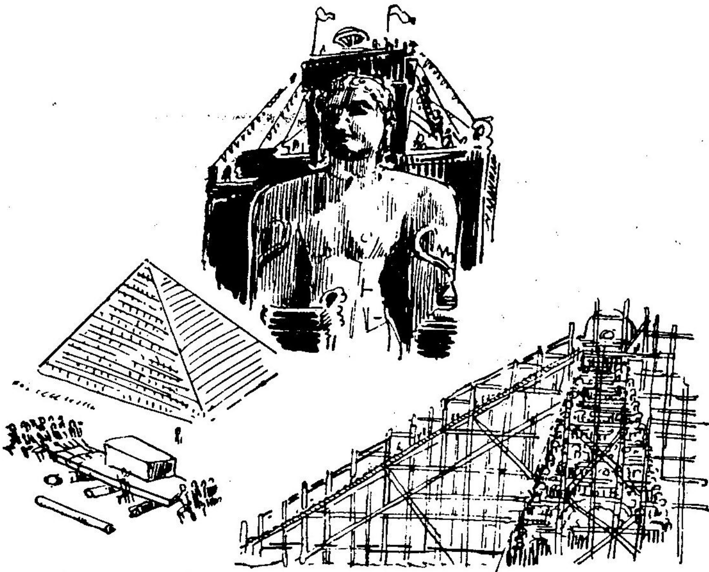


Fig. 17
Inclined Plane—Examples

Inclined Plane: The structure of the inclined plane is a right angled triangle as in Fig. 18. The hypotenuse AC is the length (l), the perpendicular side AB is the height (h) and the side BC is the base of the inclined plane.

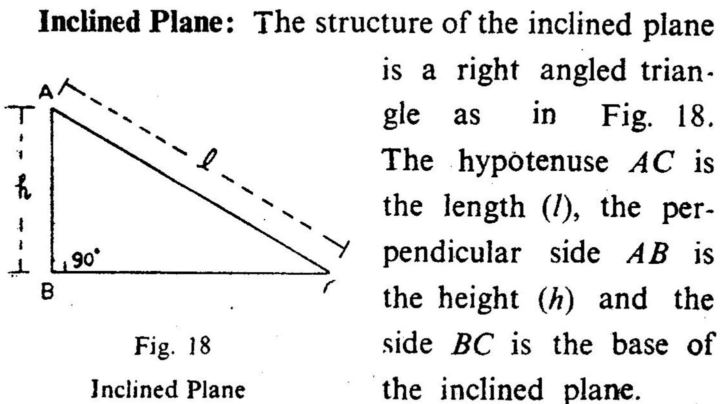


Fig. 18
Inclined Plane

To determine the Mechanical Advantage of the Inclined Plane: The mechanical advantage of any simple machine is the ratio between the weight and the power $\left(\frac{W}{P}\right)$. The mechanical advantage of the inclined plane is the ratio between its length and height $\left(\frac{l}{h}\right)$.

Experiment

Aim: To show that the mechanical advantage of the inclined plane is $\left(\frac{l}{h}\right)$.

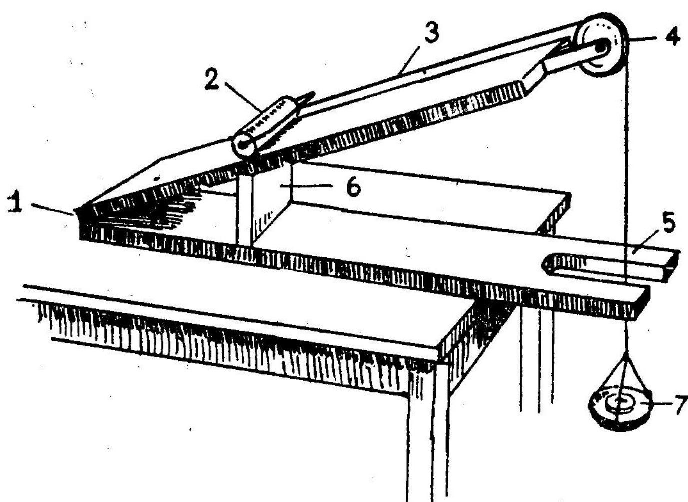


Fig. 19

1. Hinge 2. Roller 3. String 4. Pulley
5. Horizontal Plank 6. Retainer 7. Aluminium Pan

The Apparatus: Two wooden planks are hinged at one end. The top surface of the upper plank

has a glass sheet fixed to it to reduce friction. The upper plank can be fixed at different inclinations, and a rectangular piece of wood is used as a retainer to keep the inclination fixed. A metal roller is kept on it and it can move easily on it without friction. There is a fixed pulley at the top end of the upper plank. A string passes through this pulley, one end of which is attached to the roller and the other end to an aluminium pan.

Procedure: Keep the upper plank fixed at an inclination. Find the length of the inclined plane, (*i.e.*) the length of the upper plank (l cm). Find the perpendicular distance between the two open ends of the upper and lower planks. (h cm). This becomes the height of the inclined plane (h). Find the weights of the roller (W gm.) and that of the pan (a gm.). Keep the roller at the lower end of the upper plank, and increase the weight of the pan by adding weights to it. Note down the weight in the pan (P_1). when the roller moves up the plane freely at a uniform speed. After it has reached the top, decrease the weight in the pan. Note down that weight in the pan, (P_2). when the roller moves down the plane freely and uniformly. The power required to keep the roller in equilibrium (P_1) is calculated by

$$P = \frac{(P_1 + a) + (P_2 + a)}{2} \text{ gm.}$$

Repeat the experiment with various inclinations.

Record the readings in the following tabular form:

Weight of the pan $= a$ gm.

Serial No.	Weight of the roller (W gm.)	Weight in the pan, to move the roller up P_1	Weight in the pan, to move the roller down P_2	Power required for equilibrium $P = \frac{P_1 + a + P_2 + a}{2}$	Length of the Plane l	Height of the plane h	$\frac{W}{P}$	$\frac{l}{h}$
1.								
2.								
3.								

It is found that the results of the last two columns are identical. Hence the mechanical advantage of the inclined plane

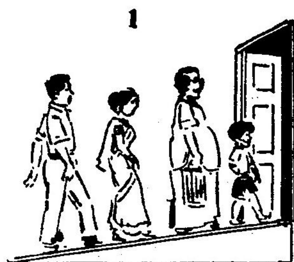
$$\frac{W}{P} = \frac{l}{h} = \frac{\text{length of the inclined plane}}{\text{height of the inclined plane}}$$

Note: The lower the height of the plane the greater is the mechanical advantage of the inclined plane.

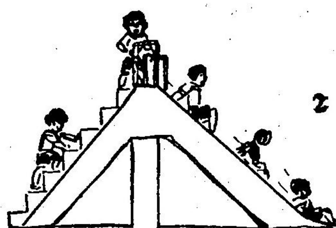
The principle of the inclined plane is adopted in (1) roads on hills and mountains (2) stairs in houses (3) Ladder (4) Roads connecting bridges in the railway level crossings.

The Wedge: The cutting edges of the axe, knife, scissors and chisel are sharp and look like the letter '*V*'. These edges are inclined to each other, and make two inclined planes. As the distance between

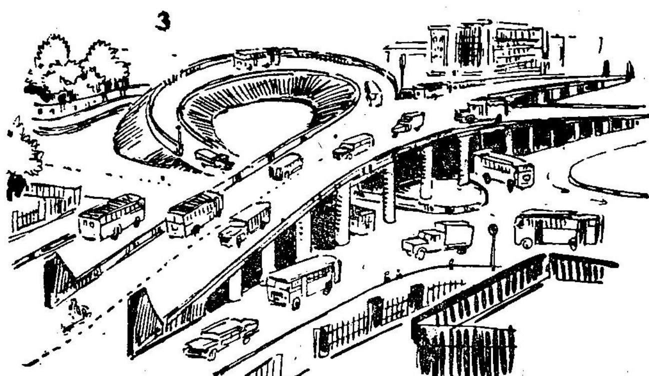
1



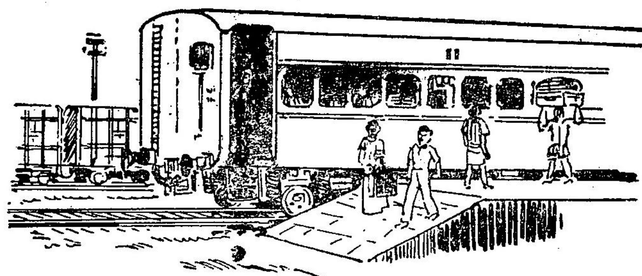
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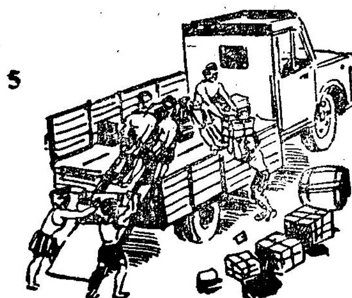
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4



5



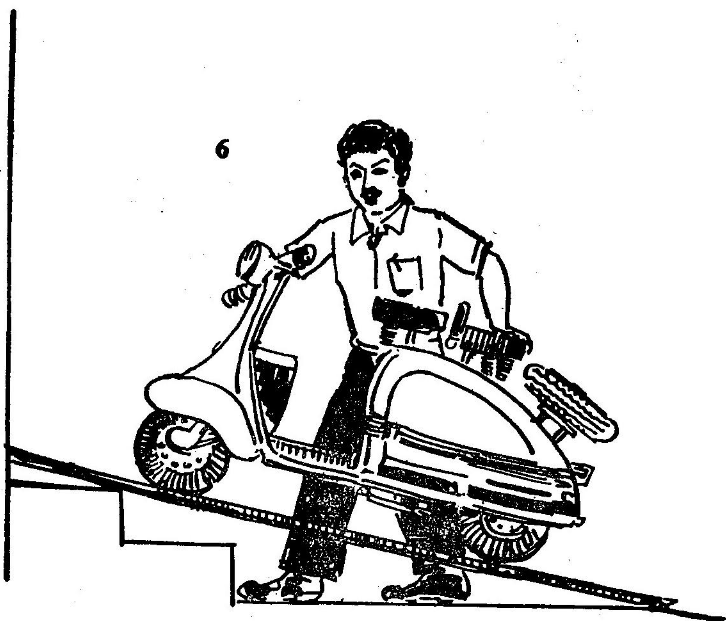


Fig. 20
(1—6) Applications of the Inclined Plane

the planes decrease, the mechanical advantage increases. Hence sharper edges cut better. So, we sharpen the edges periodically (Fig. 21).

The Screw: The screw is a common thing we always use. You would have noted the threads on them. The distance between any two threads is known as the pitch. This is also based on the principle of the inclined plane (Fig. 22).

Draw a right angled triangle *ABC* on a plain paper. Thicken the line *AC*. (Fig. 23); cut out the triangle. This is an inclined plane with the hypotenuse

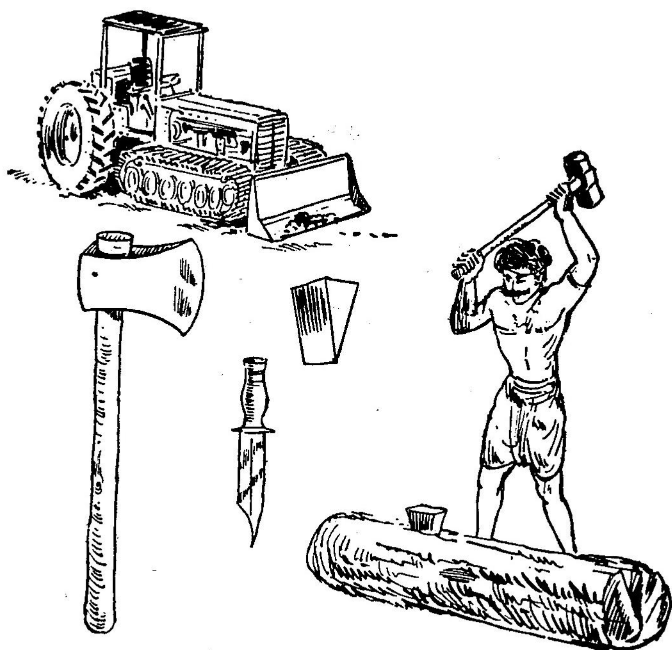


Fig. 21 The Wedge and its applications

AC as its slope-side, the vertical side AB as its height and the horizontal side BC as its base. Keep the vertical side AB tightly on a pencil and rotate it. The paper and the pencil form a screw and you can see the threads. The total length of all the threads consititute AC, It is the length of the inclined plane. The interspaces bet-

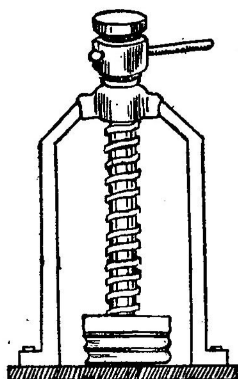




Fig. 22 The Screw-its applications

ween all the threads make the height of the plane (AB). One complete rotation of the screw head is

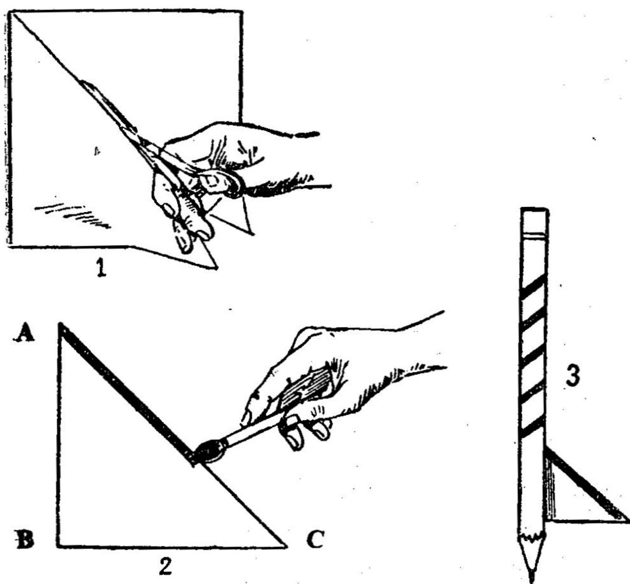


Fig. 23
The Screw is an Inclined Plane

required to move the screw to a distance equal to its pitch, given by the circumference of its head.

$$\text{Mechanical advantage of the screw} = \frac{\text{the circumference of the screw head}}{\text{the pitch of the screw}}$$

The Movable Pulley: When a system of pulleys can move up and down, it is called a movable pulley. It is a lever of the second order. A pulley is suspended from a horizontal bar through a string. (Fig. 24). The weight (W) acts at the centre of the pulley (C).

As the pull on the string passing through the point *A* makes the pulley move up or down, it is considered as the power (*P*) of the lever. As the pulley moves along the string at the point *B*, it is the fulcrum (*F*). Hence it belongs to the second order of the lever, with weight at the centre (*P-W-F.*)

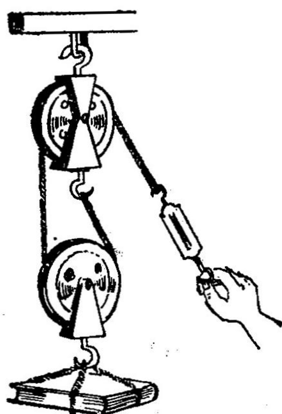


Fig. 24
Movable pulley

The mechanical advantage of the movable pulley is always two. The mechanical advandage of any order of the lever is =

$$\frac{\text{Weight}}{\text{Power}} = \frac{\text{Power Arm}}{\text{Weight Arm}}$$

Here *AB* is the power arm and *CB* is the weight arm. Hence the mechanical advantage $= \frac{AB}{CB} = \frac{\text{diameter}}{\text{radius}}$ = 2, because the diameter of any circle is twice its radius.

Note: The weight of the pulley also is to be taken into account to determine the weight of the lever. If we want to lift 100 *Kg.* and if the weight of the pulley is 10 *Kg*, then the power required to lift the weight is $\frac{100}{2} + \frac{10}{2} = 55$ *Kg.*

These are used to lift heavy loads and put them in proper places. We see cranes in loco sheds, harbours and factories. At times, we see them on wrecker

service, used to lift lorries etc. involved in accidents, derailed trains etc. Fig. 25 (*a*).

R is a revolving platform. *L* is the lever made of iron bar. The lever can be raised or lowered. *F* is a fixed pulley at the top end of the inclined frame. The weight *W* is suspended from the movable pulley *M*. The wire rope carrying the movable pulley is attached to a wheel and axle arrangement *WA* at the revolving platform, and passes through a fixed pulley at the top end of the lever frame. Loading and unloading is done by properly rotating the handle.

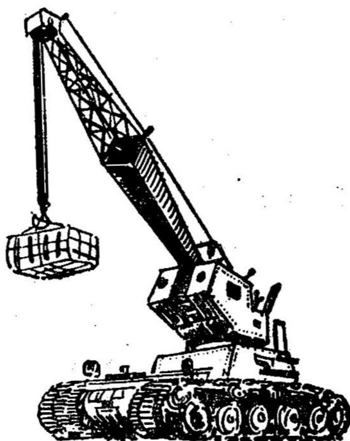


Fig. 25 (*a*)

Crane

Exercise

I. Questions

1. Write an experiment to show that the mechanical advantage of an inclined plane is the ratio between its length and height.

2. The screw is an adoptation of the inclined plane. How?

3. What is a movable pulley?

4. Show that the movable pulley is a lever of the second order.
5. Prove that the mechanical advantage of a movable pulley is always two.
6. Name some of the implements used in daily life, based on the principle of the inclined plane.

II. Pay a visit to

1. places of loading oil barrels in lorries
2. winding paths up the hills.
3. loco sheds, harbours, auto and other factories using cranes.
4. places where tube wells are sunk.
5. car repair shops where a jack is used to lift deflated tyres and replace them by good ones.



Fig. 25 (*b*)
Screw Jack

III. Do you know why

1. a sheet of glass is attached to the upper plank of the inclined plane?

6. MOTION

The body is said to be in motion when it constantly changes its position. There are two aspects of motion, one being direction and the other being speed. If a body moves along a straight path with the same

speed, it is said to have uniform motion. If, it often changes either direction or speed or both, it is said to have non-uniform motion.

You have heard about the landing on the moon. A rocket is sent up with great speed. The rocket is in motion.

Speed is displacement made per second. Speed defined in terms of direction is known as **velocity.**

The Speed-Time Graph: The speed and time taken by a displaced body can be represented by a graph. Take a graph paper and mark the *X* and *Y* axis. The time is represented in the *X* axis and the speed in the *Y* axis. The speed at different instants is recorded as per tabular column below, and the respective coordinates marked in the graph paper:

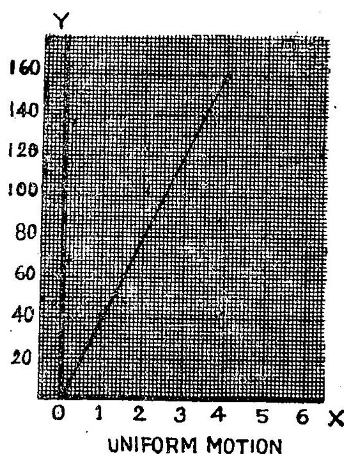


Fig. 26
Uniform Motion

The speed-time graph of a car moving at 40 kmph is given for illustration.

Table I

X axis (in sec.)	0	1	2	3	4
Y axis (in metres)	0	40	80	100	120

Table II

X axis (in sec.)	0	1	2	3	4
Z axis (in metres)	0	40	80	90	110

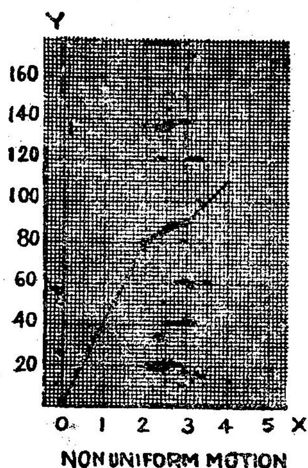


Fig. 27
Non-uniform Motion

The area represented by *OABCDE* is the distance traversed by the body.

Acceleration: When the speed of a body moving in the same direction changes, it is said to be moving with non uniform velocity. If the speed of the body increases every second, we say that body has **acceleration** and if the speed decreases we say that the body has **retardation**. We press

the accelerator of a car and increase the speed to reach the destination early. Now the car has acceleration. We apply the brakes to stop a car. Then the speed decreases. We now say that the car has retardation. If the acceleration is the same for every second, the body has a **Uniform Acceleration.**

We see bodies fall down vertically because of the earth's gravity. Here the rate of change of velocity is seen to be uniform. This is known as acceleration due to gravity (g). When a body is thrown up, it moves against the force of gravity. Hence the velocity goes on decreasing. The velocity finally becomes zero. When the body has reached the maximum height and velocity is zero, it begins to fall down due to gravity. You will learn about this in higher standards. The acceleration due to gravity varies from place to place, but is constant at a particular place. The value of acceleration due to gravity at Madras is 978 cm. sec^2.

Exercise

I. Questions

1. Explain uniform and non uniform motion.
2. Explain speed and velocity through examples.
3. How is a speed-time graph drawn?
4. What are acceleration, and acceleration due to gravity?
5. Why is there a difference in the acceleration due to gravity from one place to another?

Know yourself

That the acceleration due to gravity is greater at the poles and less at equatorial regions.

A person weighs 65.4 kg. on the surface of the earth weighs 4·1 kg. if taken to a height of 25,600 km.

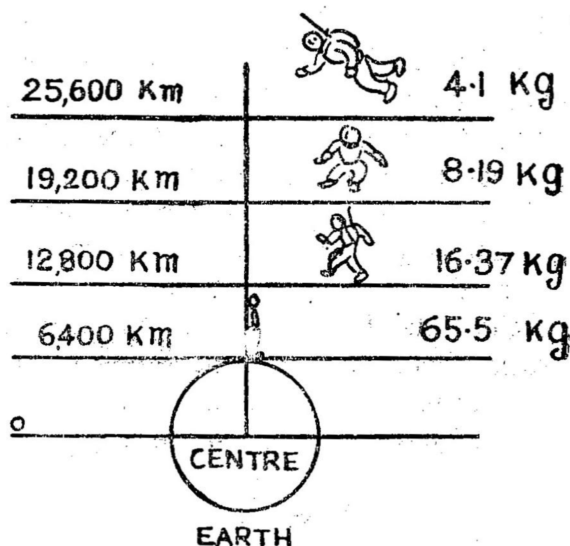


Fig. 28

Force of Gravity decreases as we go up

7. NEWTON'S FIRST LAW OF MOTION

The piece of chalk or duster or any other object placed on the table remains as it is (in that state) till it is disturbed by somebody. So also a rolling marble or ball continues to roll unless it is stopped by an agency. Under normal conditions, friction

acts as an agency to stop it. This idea is given in the "First Law of Motion" by Newton.

Law: "Every body remains in a state of rest or of uniform motion in a straight line, unless an external force acts on it."

For example a car or bus remains at rest, if it is not disturbed by anybody. When it is on the road, it has either uniform or non uniform motion. Any object lies in the same place for ever till it is disturbed.

We learn two things from this law.

(1) No body can change its state of rest or motion by itself. This inherent property to persist in the same state is known as '**Inertia**'.

(2) An external force is necessary to change the state of rest or motion of a body. **Force** is the cause which changes the state of rest or of motion of a body.

Newton has given two more laws of motion. You will learn about them in higher standards.

Exercises

I. Questions

1. State Newton's first law of motion.
2. Write short notes on - Inertia, Force.

II. Do you know why

a person jumping from a moving vehicle falls down in the direction of the vehicle?

III. Learn yourself

Immediately on touching the ground, his feet come to the state of rest. But the upper part of his body is still in motion. It moves with the direction and speed of the vehicle. Hence the person falls down.

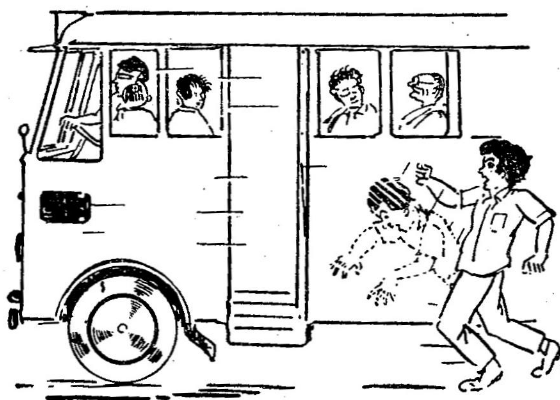


Fig. 29

Getting down from a moving vehicle

If the person runs along the direction of the vehicle and stabilises himself, he does not fall. Even this can happen while the vehicle moves slowly. If the speed is great, the fall is definite.

II. FLUIDS

8. THE PRESSURE OF LIQUIDS

Properties of Materials: The size and shape of solids can never be changed. Liquids take the shape of the container. They have a surface. The shape can easily be changed by changing the container. The volume of the liquid cannot be changed. Gases do not have a specific volume or shape. The shape can be changed. Liquids and gases are known as fluids, because they easily flow.

Pressure of a Liquid

You would have experienced the difference in weights, between an empty vessel and that filled with water. A liquid has weight. Hence it exerts a downward pressure like a solid.

Downward Pressure of a Liquid

The downward pressure of a liquid is directly proportional to the depth of the liquid.

Experiment

Aim: To show that liquid has downward pressure.

Apparatus required: A '*J*' tube, tall glass jar with water, scale, thread.

Procedure: Take a *J* tube open at both ends. Fill up three fourths of the short arm with mercury. Tie the *J* tube to a scale so that the mercury level can be measured. Now note that the mercury levels are the same in both the arms. Why is it so?

Take a tall glass jar and fill it up with water to a height. Hold the above tube so that the short arm is completely under water. Note the mercury levels. They are not equal in both arms. The level had gone down in the short arm and gone up in the long arm. The cause for this change is the downward pressure exerted by water on mercury. If the short arm is taken deeper, the mercury level also decreases in the short arm and rises in the long arm.

Upward Pressure of a Liquid

Experiment

Aim: To show that liquid has upward pressure.

Apparatus required: A small hollow cylindrical glass tube open at both ends, an aluminium disc with a hook at the centre, thread, a tall jar with water.

Procedure: Take a hollow, cylindrical glass tube open at both ends. Take an aluminimum disc, large enough to close one end of the glass tube. Tie a long thread to the hook at the centre of the disc and pass it through the glass tube. Hold the thread so that the disc closes the lower end of the tube.

Immerse the tube with the disc into the tall jar with water. When the lower end is below the water

level, leave the thread. Note whether the disc falls down. Even if the tube is immersed deeper, the disc never falls. The total downward pressure exerted by the atmosphere and by the weight of the disc is less than the upward pressure exerted by the water in the jar.

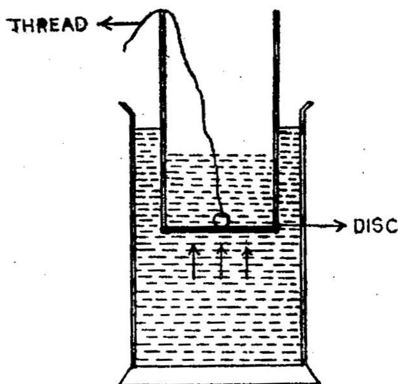


Fig. 30

Upward Pressure of a Liquid

Fill the cylindrical tube with water. When the water level in the hollow tube and in the tall jar become equal, the disc falls down because of its own weight. The atmospheric pressure in the tube and in the jar are equal.

The Sideward Pressure of a Liquid

Experiment

Aim: To show that liquids exert sideward pressure.

Apparatus required

A tall can as shown in Fig. 31, a jar of water.

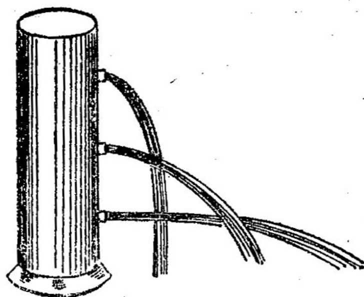


Fig. 31

Sideward Pressure of a Liquid

Procedure

Close all the three holes of the tin can with

corks. Fill it up with water. Remove all the three corks simultaneously. Note how the water spouts from the holes. Water flows with great speed from the lowest hole. The speed is less in the second and the least in the upper most hole. The experiment shows that liquid has sideward pressure. Note another point also. The speed of water coming out is directly proportional to the depth of the liquid.

At one level the upward, downward and sideward pressures of a liquid are equal.

Experiment

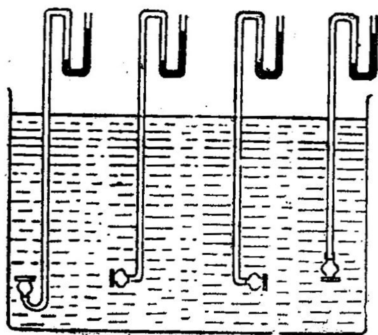


Fig. 32

Pressure of a Liquid on all sides at one level is the same

Aim: To show that at one level the upward, downward and sideward pressures of a liquid are equal.

Apparatus

Take a thistle funnel with a short arm. Connect it with a '*U*' tube by a rubber tubing. Close the mouth of the thistle funnel with a thin rubber sheet. Tie it tightly to the funnel with a thread.

Take three such sets. Fill up the "*U*" tubes to half their heights with water. Note that the water levels in both the arms of all the '*U*' tubes are equal.

Fill up a glass trough with water to half its capacity. Mark a line around the trough at a particular height from the bottom. Immerse the three thistle funnels in such a way that their mouths are on the same level with the mark. But arrange the mouth of the first funnel to point upward, the second funnel to point downward and the third to point sideward. Note the water levels in all the three '*U*' tubes. They are on the same level.

This shows that, at one level of the liquid, the upward, downward and sideward pressures are equal.

Exercises

I. Questions

1. Explain the properties of solids, liquids and gases.
2. Describe an experiment to show the upward pressure of a liquid.
3. Describe an experiment to prove that a liquid exerts downward pressure.
4. Prove that liquids have sideward pressure.

   "The upward, downward and sideward pressures at any point in a liquid are equal". Prove the statement by an experiment.

II. Find out why

1. the walls of the dam, the banks of a canal are narrow at the top and broad at the bottom.

2. the ear-drums are closed by plugging them with cotton wool while the person dives deep into water.

III. Pay a visit to

1. Vaigai or Sathanur or Malampuzha dam.
2. the main channels of Cauvery, Periyar or any other big river.

9. PASCAL'S LAW

Sometimes you play with a balloon filled with water. If you make tiny holes in it, you see water forced out through them when you press the balloon. Take a tennis ball. Make a fairly big hole and also some small pin holes in different directions in it. Fill the ball with water through the big hole close the hole by your finger and press the ball. What do you observe? You can see water rushing out through all the pin holes with uniform force. We can do the same experiment with a glass apparatus in the laboratory.

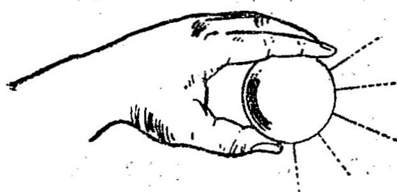


Fig. 33
Forcing Water through a Tennis ball

Take a glass apparatus as shown in Fig.34. Remove the piston and fill it up with water. Put the piston again and gently push it down. Water is forced out with uniform speed through all the pin holes.

The pressure exerted by the piston or the finger on the liquid is transmitted equally in all directions. Hence water is forced out uniformly through all the pin holes.

Blais Pascal, the French scientist has evolved a law, named after him, from the above experiment.

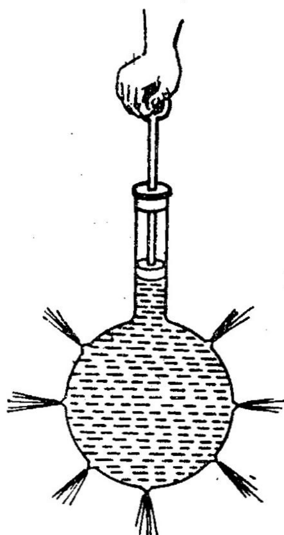


Fig. 34
Apparatus to demonstrate Pascal's law

Pascal's Law

"Pressure exerted at one point on a fluid at rest is transmitted undiminished in all directions".

Experiment

Aim: To prove Pascal's law.

Apparatus

Two glass cylinders *A* and *B* of different cross sections are connected by a horizontal tube at the bottom. They are filled with water and the water level is equal in both of them. Think why it is so. Put the respective pistons in the cylinders. The pistons have pans for putting weights. Let us assume that the cross section of the smaller cylinder is 5 cm^2 and that of the other is 100 cm^2. Put a 10 gm. weight on the smaller piston pan.

The water level goes down in it and rises in the bigger cylinder, forcing the piston up. Put a 20 gm.

weight on the bigger pan. No appreciable change is visible. Increase the weights and we see that the water level in both the cylinders are equal only when a 200 gm. weight is placed on the bigger pan.

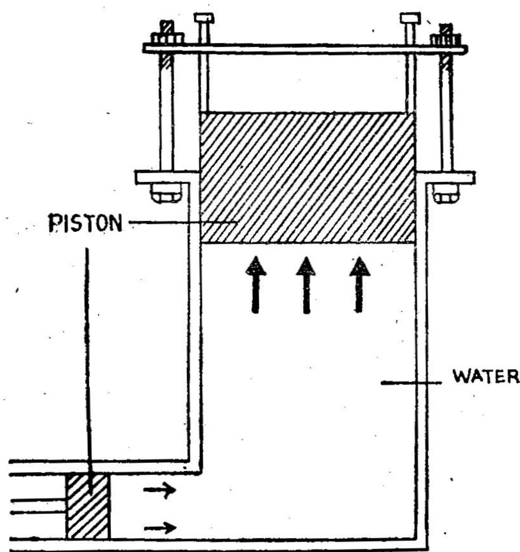


Fig. 35

Bramah Press-Principle

The pistons are in equilibrium. The 10 gm. weight put on the smaller pan exerts a pressure and the same is transmitted undiminished in all directions of the liquid in it and also in that contained in the bigger cylinder. The force is 200 gm. $\frac{100 \text{ cm}^2}{5 \text{ cm}^2} = 20$; $20 \times 10 = 200$ gm.) which we see equalised by placing a 200 gm. weight on the bigger pan. This proves Pascal's law.

The Bramah Press (Hydraulic Press)

Structure: Two metal cylinders of different cross-sections are connected with a horizontal tube. Both of them have pistons, The smaller cylinder is

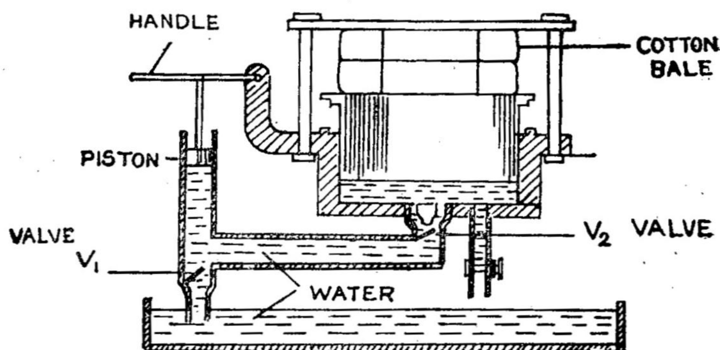


Fig 36.
Hydraulic Press

connected with a water tank at the bottom. There are two valves V_1 and V_2 as shown in Fig. 36. The piston (A) in the smaller cylinder can be operated up and down by a handle. There is an iron frame work fixed above the bigger cylinder.

Working of the Press

Push the piston up by the handle. Water comes into the smaller cylinder by opening V_1. Push the piston down. V_1 closes and water is forced into the bigger cylinder opening V_2. Through a few operations like this the bigger cylinder is filled with water. On pushing the piston again, the pressure on the liquid pushes piston B up with a force proportional to the cross sections of the cylinders. The

cotton put on the bigger piston is pressed against the frame work. After it is shrunk to the required size, the cotton is bundled in bales.

Oil is also got by crushing oil-seeds like this.

Hydraulic lifts in automobile workshops and **hydraulic brakes** work on this principle.

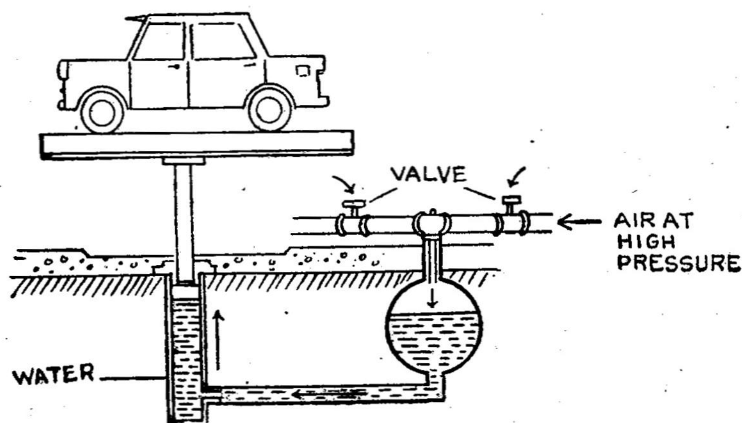


Fig. 37

Hydraulic Lifts

Diving Bell: This is shaped like a bell. There are platforms for people to stand on. It is let into the depths of the sea from a ship by chains. Air under high pressure is sent into it through pipes. It helps in two ways. Water cannot enter into the bell and people can breathe freely: Exhaled air is sucked out periodically through another pipe. People who work under water to a particular depth and pearl divers also use this device.

Nowadays deep sea fishing is done on the above principle, by letting air under high pressure through cylindrical devices.

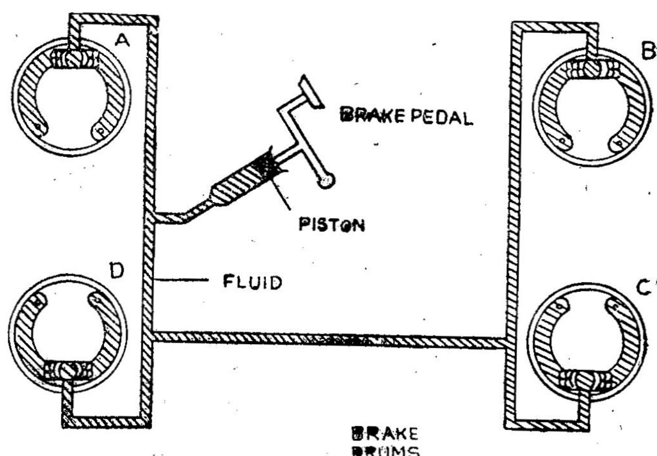


Fig 38.
Hydraulic Brakes

Caisson is used by people who work on the beds of sea or deep rivers, for putting up basements for bridges, walls laying cables etc. This a room like device of iron or concrete. It is let into the sea by chains from a ship, along with cylindrical tubes attached to it. Air is sent under high pressure into the room through the cylinders and water is displaced from the space. People work as if they are on ground level. Workmen breathe the same air and the exhaled air is sucked out through another pipe.

Cartesian Diver

This a toy like thing made of glass. A small hole is made in this through a drawn out capillary.

This floats vertically in water as there is an inside the doll and the leg portion is made heavy. Water cannot enter through the capillary of its own accord.

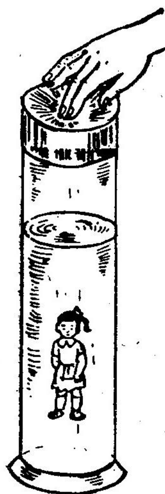


Fig. 39
Cartesian
Diver

The device is made to float vertically in a glass jar three fourths full of water. The mouth of the jar is tightly closed by a rubber sheet. When the rubber sheet is pressed by the finger, the cartesian diver sinks. The depth sunk is porportional to the pressure on the sheet. When the finger is released, the diver floats as before.

The air above water in the jar shrinks on pressing the rubber sheet. The pressure is transmitted to the water in the jar, which in turn presses the air inside the cartesian diver. The air in the diver also shrinks proportionally. Water enters the diver through the capillary and the weight of the diver increases. So it sinks. When the finger is released, the pressure comes to normal in the jar and the diver in turn. Hence the volume of air in both comes to the initial stage. The water that had entered into the diver is forced out. Therefore the diver floats again.

Submarines work on this principle. You will learn about submarines in the Eighth Standard.

Exercise

I. Questions

1. State Pascal's law.
2. Describe an experiment to prove Pascal's law.
3. How are oil seeds pressed and oil extracted through a hydraulic press?
4. Describe the cartesian diver and state how it works.
5. Describe some devices that work using the compressibility of air.

II. Learn how

1. a submarine works.
2. the brakes work in a car.

III. Do it yourself

Make a cartesian diver of glass and use it.

IV. Make a visit to:

1. places like Tuticorin, Ambasamudram, Coimbatore and see how cotton is pressed and made into bales in textile mills.
2. the docks in Cochin and Bombay and see how a submarine works.
3. places like Tuiticorin, Rameswaram and see pearl diving.
4. petrol bunks and workshops where cars are washed.

10. ATMOSPHERIC PRESSURE AND BAROMETER

Have you seen the picture of an astronaut? He wears a special suit and a mask. So also deep sea divers wear a mask and there is a cylinder of oxygen on their back. Why do they do so? They can breathe freely if only the pressure inside is equal to the pressure of air on ground level.

In the sixth standard you have learnt that air has weight and pressure. Let us now learn how the pressure is measured.

The instrument used to measure air pressure is known as the barometer. Toricelli, the Italian scientist, made the first mercury cistern barometer.

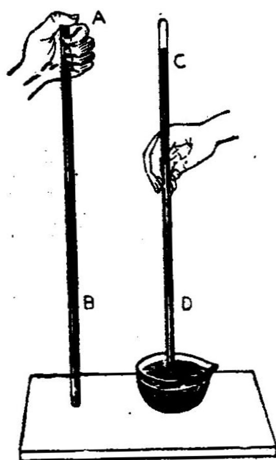


Fig. 40
Making a Cistern Barometer

The Cistern Barometer

Aim: To make a cistern barometer.

Apparatus required: A thick walled glass tube 1 m. long and 5 mm. conduit and open at one end, a cistern, mercury in a jar, a narrow stemmed thistle funnel.

Procedure: Fill half the cistern with mercury. Keep the tube clean and dry. Insert the narrow stem of the thistle funnel into the open end of the glass tube.

Pour some mercury into the tube through the funnel. Take out the funnel and close the mouth of the tube with your finger. Invert it to remove the air bubbles caught between pellets of mercury.

Repeat the same several times till the tube is full of mercury. Again close the tube with your finger and invert the tube. Put the open end of the tube under the mercury in the cistern and remove the finger. The mercury in the tube lowers to a particular level. Mark this level.

The mercury in the tube lowers to the level marked even if the experiment is repeated any number of times in a particular place.

The entire mercury column in the tube does not drain. Why? The pressure exerted by the weight of the mercury column in the tube is equal to the pressure exerted by the air above the mercury in the cistern. So the mercury column is balanced.

The pressure exerted by the column of mercury in the tube is taken to be the measure of atmospheric pressure. The height of the mercury column is the height between the mercury levels in the cistern and in the barometric tube.

At mean sea level the height of the mercury column is 76 cms. Hence the atmospheric pressure at mean sea level is "76 cms. of mercury".

Toricellian Vacuum

The space in the barometric tube above the mercury level is known as "Toricellian vacuum." It is named so to honour the scientist.

We can prove by an experiment that this space is vacuum.

Exprriment

Aim: To show that the space above mercury level in the tube is a vacuum.

Aparatus reqirred

Cistern barometer, a scale, two vertical stands and a long thread.

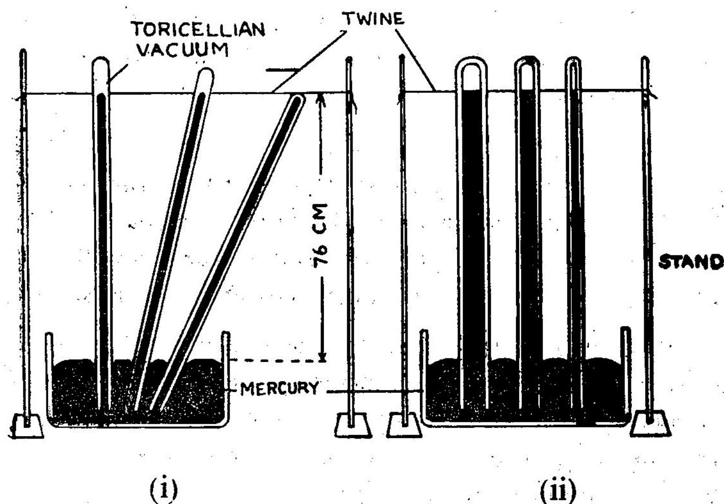


Fig. 41 Toricellian Vacuum

Procedure: Make a cistern barometer. Put each of the vertical stands on either side of the cistern. Measure the height of the mercury column in the tube. (Normally it will be 76 cms.) Tie a thread connecting the two stands. Let this thread be horizontal and on the same level as the mercury column in the tube.

Tilt the closed end of the tube slowly as in Fig. 41. Note that the mercury in the tube rises slowly without any resistance. Note also that the mercury level is always on par with the thread. When the closed end is just below the thread, the tube is completely filled with mercury.

If there had been air or any vapour above the mercury level in the tube, mercury could not freely rise into the tube. We have now seen that mercury rises freely. Hence the space must have been vacuum. This vacuum is Toricellian vacuum.

We use mercury in the barometric tube instead of any other liquid because

1. mercury has the maximum density among liquids. So the height of the barometric tube is the minimum
2. mercury does not stick to glass.
3. it is an opaque object and glitters like silver. Hence it is seen clearly through glass.
4. mercury does not vapourise easily. (Its boiling point is 629·7°*C*). The space above mercury is a clear vacuum. Minor changes in temperature does not affect the mercury level.

Uses of the Barometer

1. We can measure the atmospheric pressure in a place.
2. Weather forecasts can be made. Advance information about rain or storm can be given.

When the humidity of air is greater, the pressure of air decreases. If the mercury level in the barometer decreases steadily and considerably, rain is forecast.

If the depression is sudden, heavy wind or hurricane is forecast.

When the level increases, the air is dry and torrid.

3. The height of a place above sea level or the depth of a place underground can be found out.

Upto nearly 2000 m. the mercury level in the tube increases by 1 mm. for every 12 m. of ascent and decreases by 1 mm. for every 12 m. of descent.

Atmosphere: The atmosphere covers the earth upto a height of about 480 kms. Major portion of it is nitrogen. It further contains oxygen, carbon-di-oxide, water vapour etc. A small quantity of rare gases like neon, argon, crypton, xenon are also contained in it.

The pressure of air decreases as we go up. Atmospheric temperature decreases steadily upto a height of 12 kms. Temperature is 15°*C* to begin with and decreases steadily upto –56.7°*C* in this zone, at the rate of 0·8°*C* for every 1 mile. This is known as the **Troposphere.** Above this is the **Stratosphere.** Here the temperature is constant. Actually stratosphere extends upto 80 kms. But the temperature is constant upto 18 kms. only.

Above the stratosphere lies the **Ionosphere** Gases exist in the ionic state in this zone. Ions are charged particles. Ultra violet rays from the sun ionise

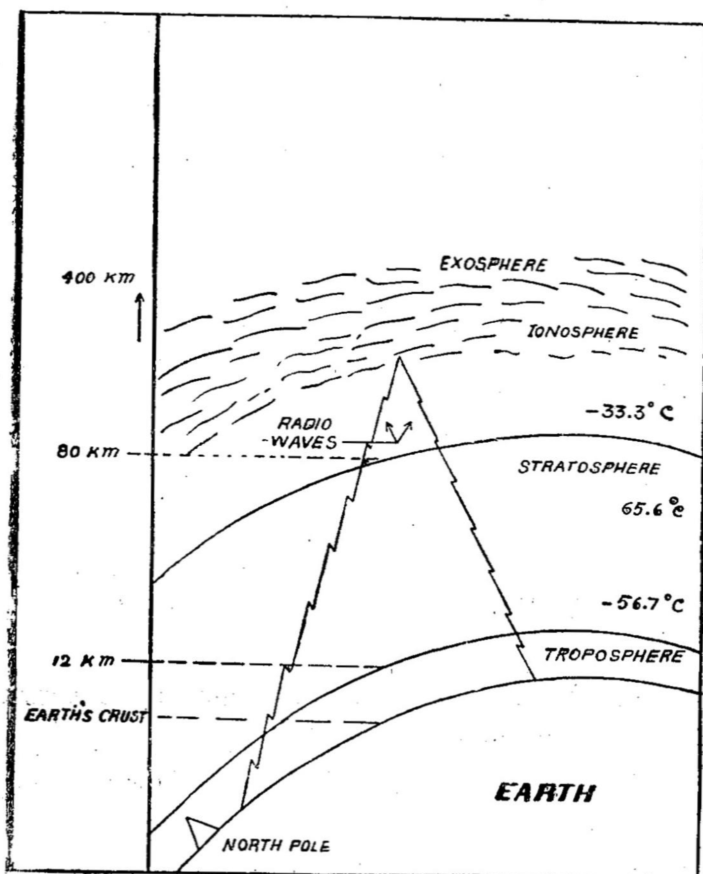


Fig. 42
Atmosphere

the gases in the air. Ionosphere is responsible for telecommunication. 480 kms. above the ionosphere is the **Exosphere.**

The gamma rays and the ultraviolet rays are in the ionosphere. The gases of the air are ionised. The energy used in ionisation weakens the gamma rays and the ultraviolet rays and so they are less harmful to the living beings.

Exercise

I. Questions

1. How would you make a cistern barometer?
2. In a cistern barometer, the space above the mercury column is vacuum. Prove this.
3. How is the vacuum in the cistern barometer called? Why?
4. What are the reasons for using mercury in the barometer?
5. What would be the height of the barometric tube if we use water instead of mercury? (Density of mercury is 13·6 gms/cm^3. density of water = 1 gm/cm^3)
6. What would be the height of a kerosene barometer?
7. How are weather forecasts made using a barometer?
8. Explain the various zones of the atmosphere and their properties.

II. Further Information

1. We can calculate the height or depth of a place to a certain extent. See the table given in the next page:

Height above mean sea level (in metres)	0	200	400	600	1000	2000
Atmosheric pressure of mercury (mm.)	760	741	722	704	674	590

Height above mean sea level (in metres)	3000	5000	10000	15000	20000
Atmosheric pressure of mercury (mm.)	526	405	198	90	41

2. A barometer is also called an altimeter.

3. Without the ionosphere, transmission and reception of signals by wireless and radio will not be possible.

4. There are barometers without any liquid (Aneroid Barometer).

5. The height of mercury column in the barometric tube does not depend on the cross section of the tube.

III. Pay a visit to

1. hill resorts and note down the pressure and altitude of the place.
2. meteorological observatories at Kodaikanal, Meenambakkam and Trivandrum.

IV. Do it yourself

1. Take an empty brasso tin. Insert a rubber tube through a hole in the lid. Pour some

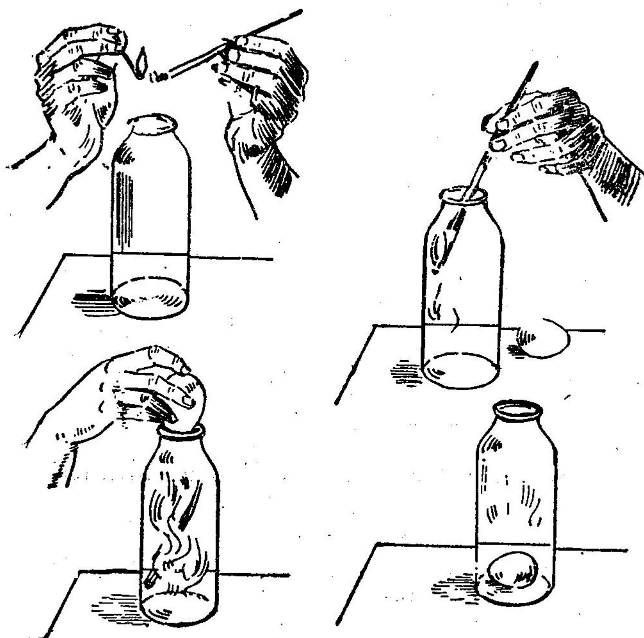


Fig. 43

water into it. Make the whole system air tight. Now heat the tin. Allow some water vapour to go out. Then close the rubber tubing by a pinch-cock, Invert the

tin and put the rubber tubing with the pinch cock, under water in a trough. Release the pinch cock and observe what happens.

2. Take a milkbottle. Burn a paper and put it inside while burning. Place a boiled egg with its narrow end over the mouth of the bottle while smoke escapes through the mouth. Observe what happens. Think and explain.

V. Do you know why

1. there is pain in the ears when an aeroplane suddenly loses height?
2. ink flows out of a fountain pen when a plane goes up?
3. there is a difference in temperature between Madras and Bangalore though they are in the same longitude?
4. a soap bubble expands and breaks?
5. Allow an air filled balloon and a balloon filled with hydrogen to fly—see what happens.

11. THE WATER VAPOUR IN THE ATMOSPHERE

Are you not happy to have iced drinks or fruit juice in summer? Hold the glass with the iced drink in your hand for a while. You can see droplets of water on the outer wall of the glass. You have not spilled the drink. Then how do these droplets appear on the glass?

We know that atmospheric air contains water vapour also. This is because of the vaporization of the water in ponds, rivers, sea etc. by the sun. The quantity of water vapour present in air is large in summer and small in winter. This water vapour in air has condensed on the glass because the air around the glass is cooled by the drink.

Experiment

Aim: To show that water vapour is present in the atmospheric air.

Apparatus required: A glass vessel, water, blocks of ice.

Procedure: Pour some water in the glass vessel. Drop some blocks of ice in it without spilling the water. Stir the mixture slowly and leave for a while. Droplets of water appear on the outer wall of the glass vessel.

From this we know that atmospheric air contains water vapour.

There will be a limit when the atmospheric air will not be able to take in any more water vapour. Now the air is said to be **saturated** with water vapour. This limit for saturation depends on the atmospheric temperature. If the temperature increases, more water vapour is needed for saturation. For instance, 25 gm. of water vapour is required to saturate one cubic metre of air at 30°*C*., 32 gm. of water vapour is necessary to saturate one cubic metre of air at 35°*C*.

If the temperature falls, the excess water vapour over and above the quantity required to saturate the air condenses into water. It is this condensed water vapour we had seen as water droplets on the wall of the glass in the previous experiment. If, in the previous example, the temperature of atmospheric air drops to 30°*C* from 35°*C*, the excess of 7 gm. (32—25) of water vapour condenses as water droplets. **The presence of water vapour in the atmospheric air is known as humidity.**

Normally, the atmosphere is not saturated with water vapour. When it is hot, we perspire. The perspiration evaporates and we feel cool. The air absorbs the perspiration because air is not saturated with water vapour. There is some more room for the water vapour to be absorbed. If air had been saturated, it would always be humid. It would not be a healthy atmosphere to live in.

We now have devices like air conditioner, air cooler etc. to keep the temperature of a place steady at the desired level.Pharmaceutical units manufacturing drugs, spinning mills and halls where computers work have such devices.

Dew: We know that the water vapour present is enough to saturate the atmosphere if the temperature falls. If there is a further fall in temperature, water vapour will condense on cold bodies. This we call dew. During early mornings in winter we can see such dew drops on leaves, blades of grass and even on stones on the ground. The atmosphere must be free of cloud for the formation of dew drops. **As the sun rises, these drops will evaporate.**

Mist: When water vapour condenses on the dust particles in the air, mist is formed. It will be like thin smoke.

Fog: If the mist is thicker, we call it fog. We see fog in hill stations. At times the fog is so thick that traffic is stopped till the mist clears.

Clouds: Air becomes lighter and goes up when it is hot. If it goes higher and higher, it gets cooled. We know that temperature falls by 1°*C* for every 100 metres height. Mist formed higher up the atmosphere is called the cloud.

Rain: Water drops condensed in the cloud are cooled further by the fall of temperature. They are very heavy and can not be borne by the dust particles in the air. They drop down on the earth as rain.

Why is rain water taken to be the purest form of water available?

Hailstones: (At times) Just before it begins to rain we see hail-stones fall. They are of the size of a pea to that of a base ball. Clouds are some times drifted up. There is further condensation. When a rain drop freezes, it is the beginning of a hailstone. Layers and layers of frozen water make up a hailstone as it falls down. If you break a hailstone, you can see the layers, as you see in an onion.

Snow: When the temperature of a cloud falls below freezing point of water, the water vapour freezes and becomes solid. It does not pass through

the liquid state. Snow consists of very small ice crystals.

Exercise

I. Questions

1. Prove by an experiment that there is water vapour in the atmosphere.
2. What is humidity?
3. What is the relation between atmospheric temperature and saturation of water vapour in it?
4. Write short notes on (a) snow (b) mist and (c) hailstones.
5. How do clouds form?
6. Why are hill stations cooler than plains?

II. Do you know why

1. water kept in mud pots are cool?
2. huts with mud walls and palm leaf roofiing are cooler in summer and warmer in winter?
3. we feel sultry when the air is humid?

III. HEAT

12. SPECIAL THERMOMETERS

Have you seen the weather chart in the newspapers? There is a special mention about the temperature recorded on the previous day, in the various observatories. The maximum and the minimum temperature registered in a day are noted there. Is it possible for any one to sit near an ordinary thermometer all day long and record the temperature variations? Further one cannot predict that such and such a temperature will be the maximum or minimum in a day.

You would have seen the temperature of a patient being recorded in the hospital chart. If you use an ordinary thermometer, the mercury level will fall down immediately after you remove the thermometer from the patient's body.

There are special thermometers to find the temperature of a patient or to record the maximum and minimum temperature of a day.

The Clinical Thermometer

The clinical thermometer is shown in Fig. 44.

Mercury is used in this as in the other thermometers. There is a cylindrical bulb containing mercury The bulb is fused to a thick capillary tube.

There is a constriction in the capillary near the bulb. This prevents mercury getting back into the bulb, after the thermometer is taken out from the patient's body.

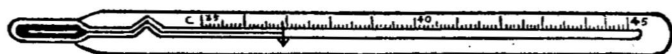


Fig. 44
Clinical Thermometer

The constriction is so arranged that the mercury level in the thermometer will fall only when we shake the thermometer.

We keep the thermometer under the tongue for one minute. The mercury level rises and indicates the body temperature. The graduations in this are not marked either as 0°*C*—100°*C* or 32°*F*—212°*F* like the ordinary thermometer or the laboratory thermometer. The natural body temperature is 36·9°*C* (98·4°*F*).

Suppose the body temperature is 41°*C* (106°*F*) or 35°*C* (95°*F*). In both cases the patient becomes critical. So it is enough if the clinical thermometer could measure temperature between 35°*C* and 41°*C*. The graduations in the clinical thermometer are between 35°*C* (95°*F*) and 45°*C* (110°*F*). The natural body temperature viz. 36·9°*C* (98·4°*F*) is indicated by a red arrow mark.

The clinical thermometer should be cleaned, everytime after use, with cold water mixed with one or two drops of dettol. It should be well shaken by a few jerks, and make sure the mercury level is

well below the constriction, before the thermometer is used again.

Six's Maximum and Minimum Thermometer

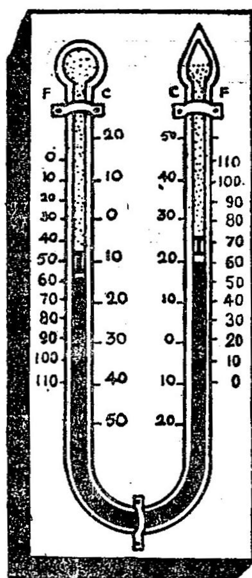


Fig. 45
Six's Thermometer

The maximum and minimum temperature of a day are registered by this. Six devised it. The thermometers showing the maximum temperature and the minimum temperature are found in the same device.

Two bulbs, as shown in the figure, are fused to the ends of a '*U*' tube. Mercury is filled in the bend upto a height and in both the arms of the '*U*' tube. Above the mercury, alcohol is filled in both the arms. The bulb marked *A* is completely filled with alcohol and the bulb *B* is half filled with alcohol. Alcohol vapour is present above the alcohol in bulb *B*. Graduations are made both in farenheit and centigrade measures in both the arms. Graduations are found in the ascending order in arm *B* and in the descending order in arm *A*. An *I* shaped steel index is found above the mercury level in both the tubes. The steel indices can be pushed up by the mercury column but cannot be pushed down. A spring attached to them prevents downward movement. So

the indices can be brought down to touch the mercury level only with the help of a magnet.

Alcohol expands quickly for a small rise in temperature. The alcohol in column *A* expands, when there is a rise in atmospheric heat, and pushes the mercury in that arm. The mercury level in arm *B* rises pushing the index up. The alcohol in that arm also vapourises and the volume of the vapour in the tube *B* can be shrunk. This makes the mercury in that tube push the index easily. If the rise in temperature is greater, the index is pushed up further. So the maximum temperature of the day is recorded by the index in arm *A*.

When the temperature falls, the vapour in the bulb *B* condenses back to alcohol. This pushes the mercury in that arm. When the mercury level recedes in that arm, it leaves the index in its place and pushes the index in the other arm. Thus the minimum temperature of the day is shown by the index in arm *B*.

Hence graduations are marked upward in arm '*A*' and downward in arm '*B*'. The temperature is shown by the lower end of the index.

The Bimetal Strip: Heat expands solids. The coefficient of linear expansion varies from solid to solid. For instance it is 18 for brass and 12 for iron. It means that brass expands more than iron.

Experiment

Aim: To show that different metals expand differently.

Things required: Two identical strips of brass and iron, an oven.

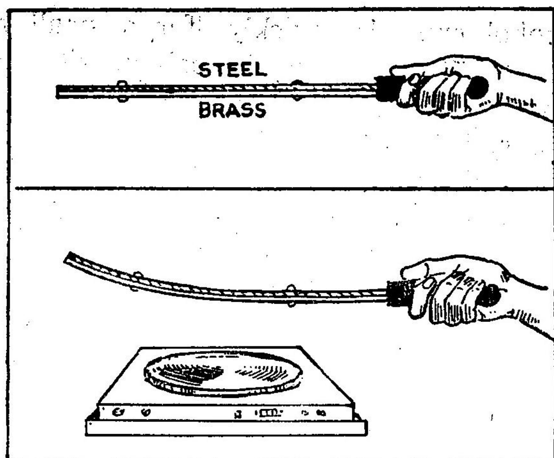


Fig. 46
Bimetal Strip

Procedure

Bind the two metal strips together and hold them by a wooden handle. Keep the strips above the hot oven for a while. You can see that the strips expand and bend. Iron is in the inner portion and brass is in the outer. This shows that brass expands more than iron.

This quality of the bimetal strip is used in the fire alarms and the recording thermometer.

The Fire Alarm

The fire alarm is found in major workshops, factories and cotton mills.

A bimetal strip is placed vertically. The lower end is connected to a battery. The upper end is very

near a screw but not touching it. The screw is connected to an electric bell. One terminal of the bell is connected to the screw and the other to the battery. As the bimetal strip does not touch the screw, the electrical circuit is not complete.

The heat evolved by the fire makes the bimetal strip bend and touch the screw. Immediately the circuit is completed and the bell rings. People rush to the spot and put out the fire. In some places, gadgets are fixed not only for the alarm but also for a direct spout of water or carbon-di-oxide on the fire.

The Recording Thermometer

Here the bimetal strip is of brass and invar. It is in the shape of a spring. One end of the spring is fixed and the other end has a pointer. A cylindrical drum rotates automatically. A graph paper with ranges of temperature marked on it, is attached to the drum. The pointer touches the paper. Normally it shows the line showing the room temperature. The pointer can mark on the paper with the ink flowing through it.

When the temperature varies, the spring expands or contracts. The pointer moves up or down and the movement is marked on the graph paper. If the drum makes one complete rotation in one day, the variations of the day's temperature can be seen marked on the graph paper.

Exercise

I. Questions

1. How are the graduations made in a clinical thermometer? Why?

2. What is the arrangement in the clinical thermometer to prevent receding of mercury?

3. What is the normal temperature of the human body?

4. State the precautions taken in using the clinical thermometer.

5. Explain the construction of the Six's maximum and minimum thermometer with a diagram.

6. How does a maximum and minimum thermometer function?

7. Why should we take the reading recorded by the lower end of the index?

8. Describe an experiment to show that brass and iron have different coefficients of linear expansion.

9. How does a firm alarm work?

10. Describe the working of a recording thermometer.

II. Further Information

1. The clinical thermometer is not put under the tongue of children and unconscious patients

It is placed under the arm pit, but 1°F or 0·56°C is added to the reading recorded by it.

2. There are special thermometers for measuring the body temperature of animals.

3. Alcohol is used along with mercury in the maximum and minimum thermometer because it vapourises and condenses quickly and easily.

III. Do you know why

1. we apply a piece of cloth soaked in Eu-de-cologne or cold water on the forehead of a patient having a temperature of 39°C or 102°F continuously?
2. the pendulum bob of a wall clock is suspended by a frame made of two different metal bars arranged alternately?
3. the clinical thermometer should not be washed in hot water.
4. The quality and growth of fruits in the following regions are alike : California in the USA, Versailles in France, Florence in Italy, the Northern region of Spain, Jammu and Kashmir in India?
5. the stem of the clinical thermometer is flat on one side and spherical on the other?

IV. Do it Yourself

1. Record the body temperature of yourself and your friends.

2. **Record the maximum and minimum temperatures on any day using the Six's thermometer of your school.**

3. Tabulate the coefficient of linear expansion of different metals.

V. **Pay a visit to**

1. factories fitted with fire alarms.
2. dispensaries
3. veterinary hospitals

13. CHANGE OF STATE

Take up an ice block. Put it in a vessel and heat it. It **melts** and becomes water. Continue the heating, it **boils** and becomes steam. It started as a solid, became a liquid and was transformed into steam (gas or vapour). This change from one state to the other is called the **change of state**.

The temperature at which a substance melts to become a liquid is known as its **melting point.** If a substance is transformed to a solid from the liquid state then that temperature is known as **freezing point.**

The melting point of ice is taken to be the lower fixed point in marking a laboratory thermometer.

Experiment

Aim: To note the melting point of paraffin wax.

Apparatus required: A narrow glass tube, a glass beaker with water, a thermometer, paraffin wax, a stand and a burner.

Procedure: Melt some paraffin wax in a glass tube by keeping it in hot water. Seal one end of the tube with the flame of the burner. Tie the tube to a thermometer. Set the bulb of the thermometer and the wax pellet in the tube to be in the same level.

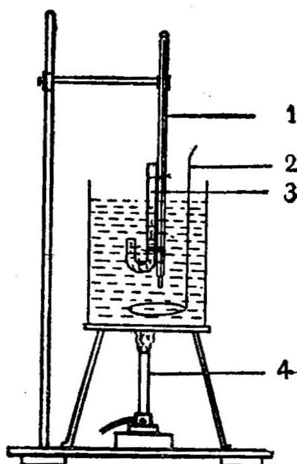


Fig. 47
Melting Point of Wax

1. Thermometer
2. Stirrer
3. Wax in a Test Tube
4. A Burner

Place a beaker with water on a stand. Suspend the tube and the thermometer from the stand. The bulb and the wax pellet should be well within the water in the beaker. Heat the beaker with the burner. Observe the wax pellet through the wall of the beaker.

The wax pellet is opaque. Note the temperature of water when the pellet has melted and becomes liquid (t_1 °C). Stop heating. The temperature will slightly rise and will begin to fall. Keep watching the tube. When the wax begins to solidify note the temperature again (t_2 °C).

The melting point of wax is given by $\frac{t_1°C + t_2°C}{2}$.

Normally it is 54°C.

Let us do the same experiment with ice.

Aim: To note the melting point of ice.

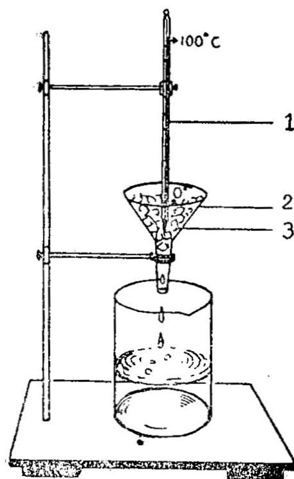


Fig. 48
Meltion Point of Ice

1. Thermometer
2. Funnel
3. Ice

Apparatus required: A glass funnel, thermometer, an empty beaker, a stand.

Procedure: Put a glass funnel on a stand as shown in the figure. Put some ice blocks in the funnel. Place a beaker below the funnel, Insert the thermometer into the ice blocks. Note the temperature. The temperature is constant at 0°*C* (32°*F*) till all the ice in the funnel melts. The melted ice drips into the beaker as water.

Boiling

When the liquid is heated, it boils and becomes vapour. This change of state from liquid to gas is boiling. The temperature at which this change takes place is its **boiling point.**

Experiment

Aim: To find the boiling point of water.

Apparatus required: A glass flask, a double holed rubber cork, a delivery tube, stand, burner and a thermometer

Procedure: Take a flask, fill it with water little than half. Fix it on the stand above the wire gauze. Close the flask with a two holed rubber cork. Insert the thermometer through one hole and the delivery tube through the other. The bottom of the thermometer and the delivery tube within the flask should be just above the water level.

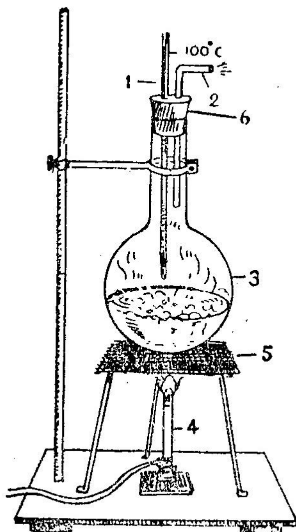


Fig. 49

Boiling Point of Water

1. Thermometer
2. Delivery Tube
3. Flask
4. Burner
5. Wire Gauze
6. Two holed Rubber Cork

Heat the water in the flask with the burner. Allow the steam to pass through the delivery tube. Now note the reading in the thermometer. It will be 100°*C* (212°*F*). (If the water is not pure, this temperature may not be 100°*C*). The thermometer will indicate 100°*C* till all the water in the flask turns into vapour.

Hence we learn that the boiling point of water is 100°*C*.

When the pressure increases, the boiling point of the liquid increases. If the pressure decreases, the boiling point decreases.

Pressure and Boiling Point

Experiment

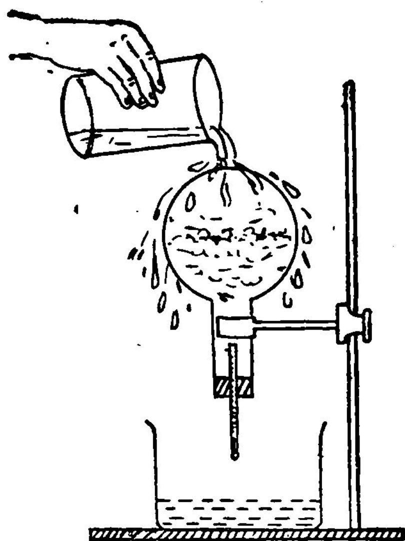


Fig. 50

Pressure and Boiling Point

Aim: To note the change in the boiling point of water due to change in pressure.

Apparatus required: Glass flask, boiling water, a one holed rubber cork, cold water in a flask and a thermometer.

Procedure: Boil some water in a glass flask. Allow some of the steam to escape. Then close the flask with a one holed rubber cork. Insert a thermometer through the hole. Note the temperature. It will be 100°*C*. Water does not boil now. Invert the flask and fix it to a stand as in Fig. 50. Allow the water in the flask to cool. The reading in the thermometer becomes say 80°*C*. Now pour some cold water on the flask. You can see the water in the flask **boiling again.**

There is water vapour in the flask above the boiled water. When cold water is poured on the flask, this water vapour condenses and becomes water again. The pressure above the water decreases.

When the pressure decreases, boiling point also decreases. Hence water boils again.

When the boiling point decreases, the water boils at a lower temperature and becomes water vapour. So substances are not properly cooked. Such a thing happens in hill stations.

Logically you may ask whether the boiling point will rise if the pressure increases. The answer is yes. The pressure cooker you use now is based on this principle only.

The Pressure Cooker

This is a vessel made of very thick aluminium sheet. It has a handle made of wood or bakelite. The lid is air tight. A rubber ring is placed in between the vessel and the lid. It is known as **gasket.** The gasket makes the vessel air tight. A provision is made for the excess steam to escape through the hole at the centre of the lid. A heavy chromium coated iron stopper closes the hole.

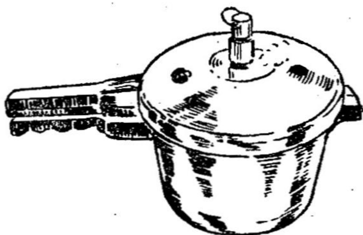


Fig. 51
Pressure Cooker

The stopper acts as a safety valve. When the pressure within the vessel mounts more than necessary, the excess steam pushes the stopper and escapes through the hole. A whistle sound is heard. Immediately the heating is stopped. The safety arrangement

prevents the cooker from bursting because of excess pressure.

Some water is poured into the vessel. The edibles like vegetables, rice etc. are taken in special containers with sufficient water and are placed into the cooker. Then the lid closes the vessel tightly. When heated, the water boils and vaporizes. The vapour cannot go out and so the pressure increases in the vessel. The pressure and temperature of the steam increases and the things put in the vessel are well cooked.

Vaporization

Let us take some water in a vessel and leave it to stand still. The water level decreases after a time. This decrease is greater when the atmosphere is hot and slow when it is normal. Did you note the water mark found on the vessel showing the initial water level? Atmospheric heat vaporizes the water. You would have seen the water sprinkled on a hot surface vaporizes immediately and the water vapour is also seen.

Liquids like ether, alcohol, chloroform vaporize quickly. Different liquids vaporize at different temperatures. Our body heat is enough to vaporize the above liquids. We feel cool when we take any of them in our palm or on any part of our body.

Boiling and Vaporization

Boiling	Vaporization
1. Takes place through the entire liquid.	1. Takes place only on the surface of the liquid.
2. Takes place at a particular temperature.	2. Takes place at all temperatures.
3. The process is quick.	3. The process is slow.

Many of you have taken ice candies, ice cream of gulfies. Have you seen the inside of the container? It is a wooden box covered with a tin sheet and there is another metal box inside. The gap between the boxes is covered with ice and salt mixture or brine. This mixture reduces the melting point of ice (0°C) and the things put inside are kept at the same temperature for a longer time. They do not melt. Calcium chloride is also used instead of sodium chloride (common salt). The mixture is called "**Freezing mixture**". In cold countries, calcium chloride is used for ice control. Alcohol mixed with water is used in car radiators.

Vulcanization

When there is a tiny puncture in our cycle tube, we put a rubber patch on it and paste it with a solution. What do we do if the tube is torn

by a sharp material like a horse shoe or a sharp stone? We ask the repairer to **vulcanize** it. It means treating rubber with materials like sulphur or naphtha at high temperature. The process is known as vulcanization. Car or scooter tubes are also vulcanized.

Exercise

I. Questions

1. What do you mean by "change of state"?
2. How can you find the melting point of paraffin wax in the laboratory?
3. How will you find the melting point of ice?
4. Write short notes on—boiling point, melting point.
5. Describe the method of finding the boiling point of water.
6. Show by an experiment that the boiling point changes with pressure.
7. Describe a pressure cooker and explain how it works.
8. Explain vaporization.
9. How do boiling and vaporization differ?
10. Explain - freezing mixture, vulcanization.

II. Further information

Liquid	Melting point Freezing point	Boiling Point
Water	0°C	100°C
Ethyl Alcohol	—15°C	78°C
Mercury	—39°C	6297°C
(Liquid) Iron	1500°C	3235°C

2. The temperature remains constant during the change of state (solid to liquid or liquid to gas or vice versa). Though heat is involved, it is not shown by the thermometer. The heat taken for melting of the solid is known as the "Latent heat of fusion".

3. The heat taken for the liquid to become vapour is known as "Latent heat of vapcrization".

4. If salt is mixed with water, the boiling point is raised and the freezing point is lowered.

5. In the pressure cooker, the stopper on the lid should not be removed immediately after the whistle sound is heard.

III. Do it Yourself

Take equal quantities of water in two identical vessels. Cover one vessel by ice blocks and another with a mixture of ice and salt. Which vessel has the water frozen first? Why?

IV. Pay a visit to

1. the ice factory near your place.
2. hill stations.
3. places using pressure cooker (or shops selling pressure cooker).

IV. LIGHT

14. REFLECTION OF LIGHT

Take a piece of a plane mirror, a well polished stainless steel plate and a varnished wooden piece. Stand in front of each of them and look at your image formed on their surface. It is very clear and sharp in the mirror, clear but not sharp in the steel plate and dull in the wooden piece.

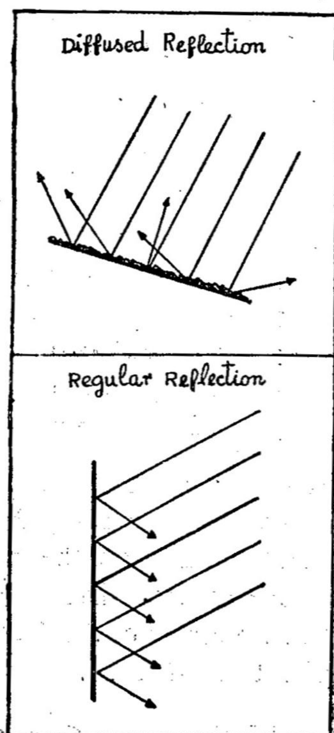


Fig. 52

The surface of the plane mirror and polished plate are perfectly linear and even and could reflect the rays of light totally in the same direction. This is known as **regular reflection.** When the surface of reflection is not even as in wood, the rays of light falling on it are not reflected exactly in the same direction. Hence it is known as **irregular reflection.**

During day-time we see the objects because the sunlight, which falls on them, is reflected.

Glass, polished metal plate etc. have regular reflection. Such surfaces are known as **mirrors**. When the surface is plane, it is called a **plane mirror**.

Reflection in Plane Mirrors

Experiment

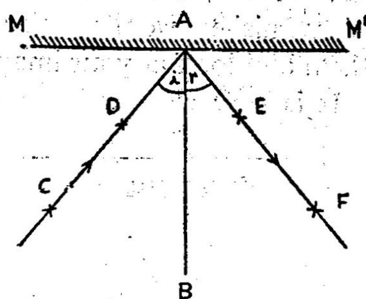


Fig. 53

Plane Mirror

1. *MM'* Plane mirror
2. *CDA*—Incident ray
3. *AEF*—Reflected ray
4. *i*—Angle of Incidence
5. *r*—Angle of Reflection

Aim: To verify the laws of reflection by a plane mirror.

Apparatus required: A plane mirror, drawing board, paper, long pins, pencil and prot ractor.

Procedure: A plane mirror is fixed into the groove of a piece of wood. Place the drawing board on a table. Fix a sheet of paper on the board using drawing pins. Place the plane mirror vertically with its wooden frame on the sheet of paper. Draw a horizontal line on the paper touching the reflecting surface of the mirror. Let it be *MM'* Fix a point *A* at the centre of *MM'* and draw the line *AB* perpendicular to *MM'* at *A*.

Mark a point *C* on one side of this perpendicular *AB* and fix a long pin there. View this pin through the mirror at an angle to the line *AB*. Fix another

pin *D* in the same side and the two are in the same line of vision.

Similarly fix two pins at *E* and *F* on the other side of the line *AB*. The two pins are in the same line of vision, as the images of the pins *C* and *D*.

Now take away the mirror and the pins. Join the points *C*, *D* and *A* by a straight line. Join the points *FEA* also by a straight line. The figure obtained will be as in Fig. 53.

Measure $\angle CAB$ and $\angle FAB$ with a protractor. Both the angles are found to be equal.

Repeat the experiment several times by changing $\angle CAB$. It is seen that $\angle FAB$ will also change and that it is always equal to $\angle CAB$.

Definitions: In Fig. 53, *MM′* is the reflecting surface of the mirror.

AB is the line drawn perpendicular to the reflecting surface.

A is the point of incidence.

The **incident ray** (ray of light incident on the reflecting surface) is denoted by the line *CDA*.

The **reflected ray** (ray of light reflected from the reflecting surface) is shown by the line *AEF*.

$\angle CAB$ is known as the **angle of incidence** and $\angle FAB$ is known as the **angle of reflection.**

The plane mirror and the sheet of paper are perpendicular to each other. Hence the incident

ray, the reflected ray and the normal lie in a plane perpendicular to the mirror. All the three meet at the point A. The angles of incidence and reflection are equal. The angle of incidence is denoted as i and the angle of reflection as

Laws of Reflection

(1) The incident ray, the reflected ray and the normal drawn at the point of incidence lie on the same plane. This plane is perpendicular to the plane of the mirror.

(2) The angle of incidence and the angle of reflection are equal. The incident ray and the reflected ray lie on either side of the normal at the point of incidence.

Characteristics of Images in a Plane Mirror

You have learnt about the pin hole camera in the sixth standard. The image can be seen on the ground glass screen. But we cannot get the image formed in the plane mirror on the screen.

The image formed on the screen in a pin hole camera is a **real image.** The image we see in a mirror but cannot catch on a screen is known as a **virtual image.**

Stand before a plane mirror. Lift your right hand. The image in the mirror lifts the left hand. Have you noted this? This is known as **lateral inversion.**

Place a plane mirror vertically. Draw a line perpendicular to it marked in metres. Stand at a

point and move to the next metre mark towards the mirror. The image also moves one metre towards you. Hence we know that **the distance between**

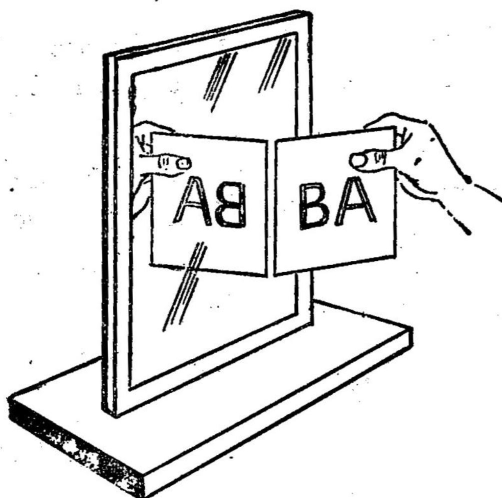


Fig. 54
Lateral Inversion

the mirror and the object is equal to the distance between the mirror and the image.

The size of the image in a plane mirror is exactly the same as that of the object placed in front of the mirror.

The image of an object placed vertically before the mirror is also vertical. If the object is inverted, the image also is inverted. If it is oblique, the image looks oblique. Hence **the virtual image formed is erect in terms of the object.**

To summarise we know that the image formed on a plane mirror,

(1) is a virtual image.

(2) has lateral inversion

(3) is exactly at the same distance behind the mirror as the distance of the object in front of the mirror

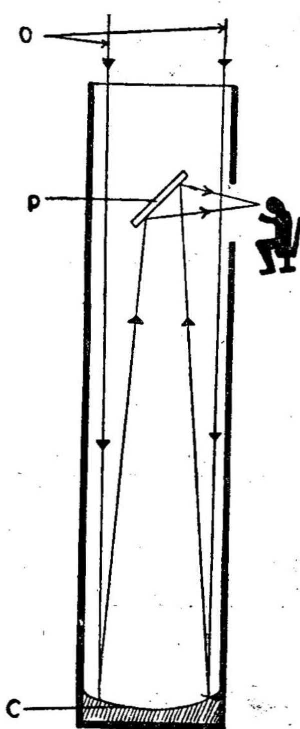


Fig. 55

Reflecting Telescope

P— Plane mirror

C— Concave mirror

O—Rays from object

(4) is of the same size as that of the object and

(5) is erect in terms of the object.

Uses of Plane Mirror

(1) The plane mirror is used as a looking glass.

(2) It is used to reflect the light rays on an object or a place. It is used in this way to reflect the sunlight on actors in an out door shooting.

(3) It is used in instruments like **Kaliedoscope** and **Periscope.**

(4) It is used in reading the composed galley in the printing press.

(5) It is used in **Epedioscope.**

(6) It is used in **Astronomical Telescopes.**

Luminous and Non-luminous Bodies

Have you seen the watch or a clock with radium dial? (It is not radium but a compound of phosphorous). The sun, the stars, the fire and electrical lamps are all **luminous objects** They emit light by themselves.

Other objects get light from the luminous objects and shine. So they are seen by us. If there is total darkness in a room, we cannot see any object there. There must be some light for us to see an object. Such things which do not emit light by themselves but merely reflect the light of the luminous objects are known as **Non-luminous objects.**

Take a plate of glass and look through it. Look through clear water. You will be able to see the other side of the glass or water. Such objects that allow the light to pass through them are known as **transparent objects.**

Example: Glass, clear water, oil.

Take a ground glass or a paper soaked in oil. Look through any one of them. Light

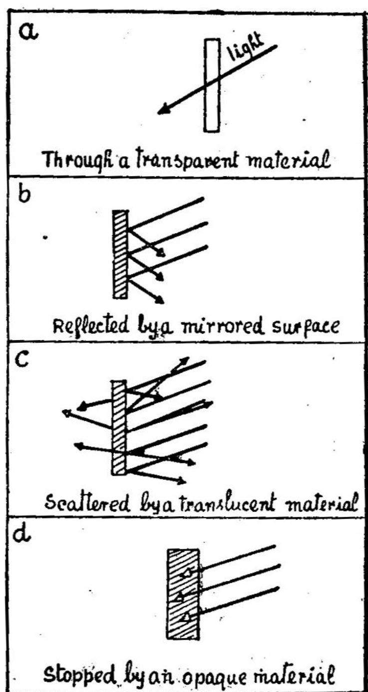


Fig 56.

passes through but only partially. The objects on the other side are not seen clearly. Such objects are known as **translucent objects.** Example: ground glass, butter paper, sea water.

Objects like wood, stone, iron do not allow light rays to pass through them. We cannot see through any of them. Such objects are known as **opaque objects.**

Any object which allows light to pass through it completely or partially is known as a **medium.** Glass, water and air are media of light. But glass is denser than water. Water is denser than air. So glass is a denser medium when compared to water. Water is a denser medium when compared to air. The term **denser medium** or **rarer medium** is only comparative.

Exercise

I. Questions

1. Explain regular and irregular reflection.
2. State the laws of reflection.
3. How would you verify the laws of reflection ?
4. Define: incident ray, reflected ray, angle of incidence and angle of reflection.
5. What are the characteristics of an image in a plane mirror ?
6. Explain any two of them.
7. What are the uses of a plane mirror ?

8. Write briefly about - luminous and non-luminous bodies, transparent, translucent and opaque objects and denser medium.
9. Explain the terms real and virtual images

II. Do it Yourself

1. Observe the lateral inversion in a mirror.
2. Measure the distance between the object and the image from the mirror.
3. Construct a kaleidoscope.
4. Construct a periscope.
5. What should be the height of the plane mirror to reflect the full figure of a man?

III. Know Yourself

Use the word LEEEV to remember the characteristics of the image in a plane mirror. (Lateral inversion Equal in size, Equal in distance, Erect and Virtual)

VI. Is it true that

1. cats can see well even in total darkness?
2. all the planets in the solar family are luminous?

15. REFRACTION OF LIGHT

You have learnt that light travels in a straight line. Further you know about the denser and the rarer media. What will happen when a ray of light passes from one medium to the other?

Place a one rupee coin in a porcelain trough. Move your eye till the coin is hidden by the edge of the trough. Keep your eyes in that position. Pour water into the trough. The water level in the trough rises. At a particular level the coin will be visible to the eye.

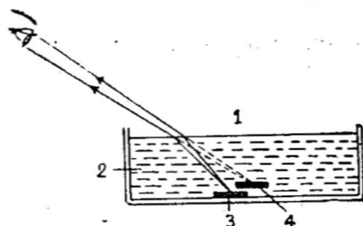


Fig. 57

Coin seen raised in water

1. Rarer medium - air
2. Denser medium - water
3. Object
4. Object (raised)

Take a beaker and fill half of it with water. Put a pencil in a slanting position. A part of the pencil is below the water and the other part above. The pencil seems to be broken and bent just at the water level.

These show that light rays refract. Air and water are two different media. Water is denser than air. When the ray of light passes from one medium to the other, it is bent slightly from its original path. This property of light is known as the **refraction of light.**

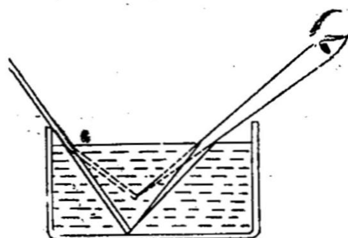


Fig. 58
Pencil appears to be broken in water

Experiment

Aim: To show refraction of light

Apparatus required: A rectangular slab of glass, long pins, drawing pins, drawing board, pencil, paper and scale.

Procedure: Place the drawing board on the table. Keep a paper on it and fix it to the board with the drawing pins. Place the glass slab on the paper and draw a close outline of the slab. Let it be *ABCD*. Fix two pins *E* and *F* so that they are placed at an angle to the side *AB*.

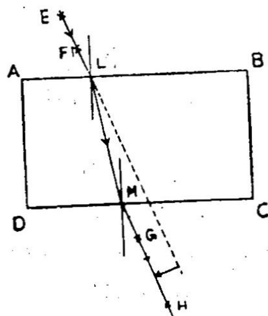


Fig. 59
Refraction

1. Rectangular slab
2. *EL*—Incident ray
3. *LM*—Refracted ray
4. *MH*—Emergent ray

View the two pins *E* and *F* through the other side, *CD*, of the slab. Fix two more pins *G* and *H* on this side of the slab, so that *G* and *H* are in the same line of sight.

Remove the glass slab and the pins. The marks are properly made about the slab (*ABCD*) and the pins (*E,F,G,H*). Join *EF* and extend the line. Let it meet *AB* at *L*. Extend it further by a dotted line. Join *HG* and extend the line. It meets *CD* at *M*. Join *LM*. Draw normals to *AB* and *CD* at *L* and *M* respectively.

EL denotes the incident ray. *MH* shows the ray coming out of the slab after refraction. The extended line *EL* shows the normal path of the ray,

if no slab is there. Hence we know that light ray suffers **refraction.** The distance between the dotted line and MH is known as **lateral displacement.** So, lateral displacement is the distance by which the ray of light is displaced from its original path.

Note: When air and glass are taken, air is a rarer medium and glass is a denser medium. When the ray of light passes from the rarer medium into the denser medium, it is refracted towards the normal at the point of incidence. If it passes from a denser medium into a rarer medium, it is displaced away from the normal. In Fig. 59 look at the changes in the path of the ray of light at the points L and M.

Refractive Index

In refraction there is a displacement in the path of the ray. As we have already seen, the coin put in a trough appears to be at a lesser depth when water is poured in the trough. We take air as the normal medium for light. The depth at which a coin is in air is taken as the **actual** depth. When the coin is in a denser medium than air, the depth at which the coin seems to be is known as **apparent depth.** The apparent depth varies from medium to medium. The reason for this is that the densities of the media vary. There is a reduction in the velocity of light and as the medium becomes denser and denser, velocity decreases. It gets darker and darker as one goes deeper and deeper into the sea.

The ratio of the velocity of light in air and the velocity of light in any medium is known as the refr-

active index of that medium. It is indirectly proportional to the apparent depth of an object in that medium.

The refractive index of a medium

$$= \frac{\text{velocity of light in air}}{\text{velocity of light in the medium}}$$

$$= \frac{\text{actual depth}}{\text{apparent depth}}$$

The refractive index is denoted by the Greek letter μ (Mew).

Illusions caused by Refraction of Light

(1) The coin is hidden from the view by the edge of the trough. It becomes visible when water is poured into it.

(2) The pencil which is kept in a slanting position

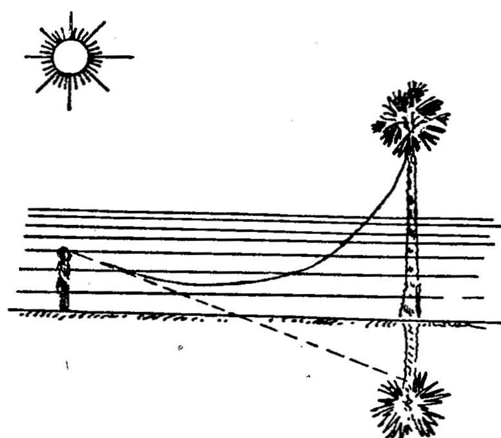


Fig. 60
Mirage

partially into a beaker with water seems to be bent and broken at the water level.

(3) Keep a glass slab on a page of your text book. The letters seen through the slab seem to have been lifted closer to you.

(4) Objects under clear water do not seem to be at their real depth but seem to be raised.

(5) The mirage: There seems to be water very close but actually there is no water. We can see such an illusion on a very hot day on tarred roads (Fig. 60).

(6) The sun is visible to our eyes, just before sunrise and just after sunset, though it is actually below the horizon at that time. This happens due to refraction of the sun's rays in the atmosphere.

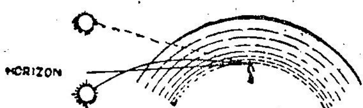


Fig. 61
The Sun is visible before Sunrise

Exercise

I. Questions

1. What are denser and rarer media?
2. Show by an experiment that there is refraction of light, when a ray of light passes from a rarer to a denser medium.
3. What is 'refractive index' of a medium?
4. Write briefly about lateral displacement, actual depth, and apparent depth.
5. Explain any two illusions caused by the refraction of light.

Further information

Hot air becomes lighter and goes up. The hot and cool air act as two different media.

16. GLASS PRISM AND DISPERSION OF LIGHT

Have you seen the rainbow on a rainy day? It is formed just above the horizon, either in the morning or in the evening. This is due to dispersion of the sunlight into its seven component colours.

Now recapitulate the previous lesson. We have learnt about the refraction of light when it passes through two different media. When a ray of light passes from a rarer into a denser medium, it is refracted towards the normal at the point of incidence. If it passes from a denser to a rarer medium, it is refracted away from the normal.

Let us learn now about the refraction of light through a triangular glass prism.

Experiment

Aim: To learn about refraction of light through a glass prism.

Apparatus required: A triangular glass prism, drawing board, long pins, drawing pins, paper, pencil, scale.

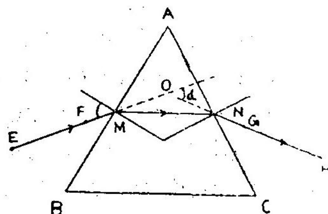


Fig. 62
Refraction through a Glass Prism

Procedure: Place the drawing board on the table. Fix a sheet of paper on it by the drawing pins. The triangular glass prism has three sides at an angle of 60° to each other and two triangular sides parallel to each other. Place the prism on the sheet of paper on one of its parallel sides. Draw an outline of the prism *ABC* on the paper. Fix two pins *E,F* vertically on the paper so that *EF* makes an angle with one side of the prism. View the pins through the opposite side of the prism. Place your eyes such that the two pins *E, F* are in one line. Now fix two other pins *G, H* on this side of the prism, and also in the same line as *EF*.

Remove the pins and the prism. Mark *A, B, C, E,F,G,H* clearly. Join *EF* and extend. Let it meet the side *AB* at *M*. Join *HG* and extend. Let it meet the side *AC* at *N*. Join *MN*. Draw also two normals at *M* and *N*. *EF* is the incident ray. It is refracted towards the normal at *M*. It is further refracted away from the normal at *N*. *GH* is the final refracted ray. In both cases the light ray is displaced towards the base of the prism.

Extend *EF* beyond *M*, and extend *HG* beyond *N*. They meet at *O*. The angle between *EF* and *HG* at *O* is known as the angle of deviation (*d*). The angle of deviation is the angle by which the incident ray has deviated from its normal path to the refracted ray) between the incident ray and the emergent ray.

Dispersion of Light: We have seen the rainbow. We know that it is due to the dispersion of sunlight.

Sir Issac Newton demonstrated this by an experiment

Experiment

Aim: To see the dispersion of sunlight through a triangular glass prism.

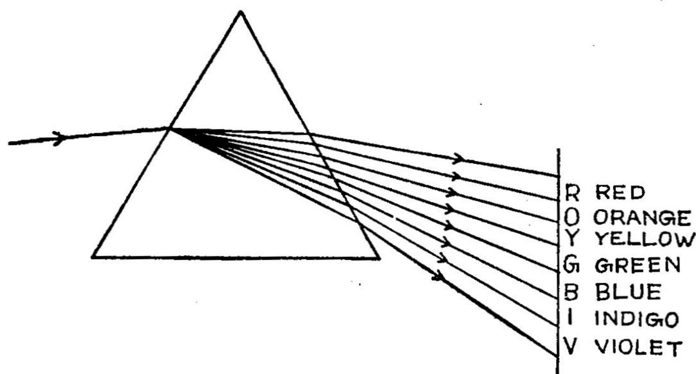


Fig. 63
Dispersion

Apparatus required: Plane mirror, triangular glass prism, a cardboard with a small hole, a white screen

Procedure: Place the triangular glass prism on the table on one of its angular sides. Reflect a beam of sunlight on it by the plane mirror. Place the cardboard between the plane mirror and the prism. This arrangement makes a small ray of light fall on the prism. The ray falls on one of the angular sides (other than the base) and is emergent through the opposite side. The emergent ray is not one single ray of white light but is of seven colours. Place the white screen so that the emergent rays of seven colours

fall on it. Now the colours are clearly seen. The colours, as we observe, are in the order of red, orange, yellow, green, blue, indigo and violet. This is known as **visible spectrum of light.** It is also known as the **vibgyor** (coined with the first letters of the colours).

Formation of Rainbow: Raindrops act as glass prisms. Sunlight and raindrops are necessary for the formation of the rainbow. The sunlight passing through them are dispersed into the seven colours. We get the rainbow because of the dispersion by many raindrops. The rainbow appears in the west in the morning and in the east in the evening. It always appears in the direction opposite to the sun.

At times we see a secondary rainbow above the primary rainbow. It is dull and the order of colours is reversed. You will learn about it in the ninth standard.

The Coloured Object: Any coloured object absorbs all the colours other than its natural colour. Let us see a white object through glasses of different colours. If we see it through a green glass, it appears to be green and appears red through a red glass. When the sunlight falls on the coloured object, it absorbs all the other colours and is seen in its natural colour. Thus we see flowers and leaves in their natural colours. Look at a green leaf through a red glass. How does it look? Examine why. All black objects absorb all the colours and do not reflect any light and so appear dark.

Exercise

I. Questions

1. Describe an experiment to show the refraction of light through a triangular glass prism.
2. Explain - angle of deviation, dispersion.
3. What is a spectrum of light?
4. Describe an experiment to show the dispersion of sunlight.
5. How does a rainbow form?
6. What are the natural conditions for the formation of a rainbow?
7. What are the differences between the primary and the secondary rainbows?

II. Know Yourself

1. The emergent ray in a triangular prism refracts towards the base.

2. The colour combinations of the **vibgyor** are - violet and blue give indigo; blue and yellow give green; yellow and red give orange.

3. The rainbow appears just above the horizon when the sunlight falls obliquely on the raindrops.

4. The spectrum appears on water falls and fountains also.

5. The angle of elevation of the red colour is 42° and that of violet is 40°.

6. Immediately on either side of the visible spectrum lies the infrared ray and ultraviolet ray.

7. The infrared rays are abundant in the early mornings and the ultraviolet rays are abundant in the late evenings.

17. SPHERICAL MIRRORS

Have you seen your face in a stainless steel spoon? Both the surfaces reflect your image. Are they plane surfaces? No. They aren't. They are curved. Such curved reflecting surfaces are known as **spherical mirrors.**

Cut off two pieces from a hollow metallic sphere. Polish the inner surface of one piece and the outer surface of the other. Let us say that the other parts of the metallic sphere could not reflect light.

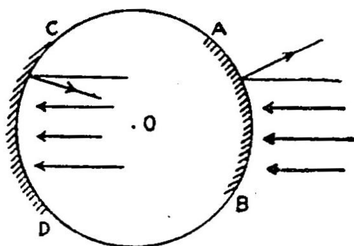


Fig. 64
Spherical Mirrors
AB—Convex mirror
CD—Concave mirror
O—Centre of Curvature

Definitions: The inner surface of one piece reflects light. It is caved in. This is known as a **concave mirror.**

The outer surface of the other piece reflects. The surface is bulged out. This is known as a **convex mirror.**

We took out two pieces from a metallic sphere. The centre of the sphere of which the mirrors are taken is called be **centre of curvature** of the spherical mirror.

The centre of the mirror is known as the **pole of the mirror.**

The straight line joining the pole of the mirror and its centre of curvature is the **principal axis** of the mirror.

Concave Mirror

Experiment

Aim: To find the principal focus and the focal length of a concave mirror.

Apparatus required: A concave mirror, stand, piece of cotton or a film negative, a white screen and a scale.

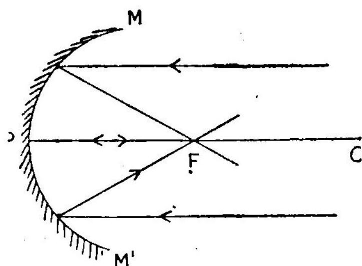


Fig. 65.
Concave mirror

Procedure: Fix the concave mirror on a stand. Turn it to face a distant object like a tree. Place the white screen in front of the mirror and get the image of the tree on it. Adjust the mirror and screen to get a clear image. Measure the distance between the mirror and the screen.

Reflect sunlight on a concave mirror by a plane mirror. The concave mirror reflects it in turn and

the rays of light converge at a point. Put an exposed negative film at the point. It catches fire soon. Measure the distance between the point of convergence and the mirror. In both cases the distance between the mirror and the point are the same.

Definitions: The point of convergence of the rays reflected by the concave mirror is the **principal focus** of the mirror.

The distance between the pole of the mirror and the principal focus is known as its **focal length.**

The image formed by the concave mirror at its focus can be got on a screen. It is a **real image.** It is a clear, inverted image.

Place an object within the focal length of the mirror. You get a virtual image of the object in the mirror.

Hence when objects are placed within the focal length of a concave mirror, we get a virtual image and if placed away from the focus, real images are formed.

Concave mirror is used

1. as the reflector in a torch light.

2. as the reflector in the head light of vehicles like scooter, car, bus, etc.,

3. as the reflector in the cycle lamp, either with dynamo or otherwise.

4. to throw powerful light on the film in a cine-projector.

5. to throw light on the interior of the eye, the ear, the nose or the throat, in instruments used for medical investigation,

6. to get a clear vision of the object placed under a microscope for analysis.

7. as a reflector in a reflecting type telescope

8. in search lights during wartime or by the police in some cases, and

9. as a shaving mirror.

Convex Mirror

Towards the right side of the driver of the bus or the lorry, a mirror is placed. It is a convex mirror. The images formed are very small.

You take a stainless steel spoon and sec your figure on the convex side of the spoon. The image is very small. But larger area is covered by the mirror.

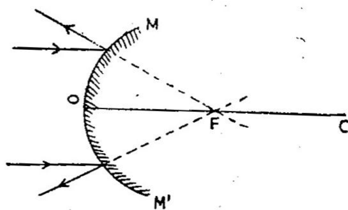


Fig. 66
Convex mirror

Turn the convex mirror towards a distant tree as you did with a concave mirror. Place a screen before the mirror. The image of the tree is not formed on the screen. So, the convex mirror produces only a virtual Image.

You know that there are principal focus, the axis, the centre of curvature and the pole of the mirror

for a convex mirror as in the concave mirror. The principal focus is explicit in the concave mirror but in the convex mirror it is the point from which all the reflected rays seem to emerge.

The convex mirror is used

1. in the bus, or lorry or cycle to note the vehicles coming from behind.

2. as a piece of design on some of the plane mirrors.

Exercise

I. Questions

1. What are spherical mirrors?
2. How would you measure the focal length of a concave mirror?
3. Define: the centre of curvature, the pole of the mirror and the principal axis of a spherical mirror.
4. How will you locate the principal focus of a concave mirror?
5. What are the characteristics of the image formed by a concave mirror?
6. State the uses of a convex mirror.
7. State where the convex mirror is used.

II. Do it Yourself

Burn a film negative by a concave mirror.

III. Pay a visit to

1. any circus and see the search light in action and
2. any cinema house and see the projector in operation.

18. LENSES

You have seen many people wearing glasses. The glass pieces in the spectacles are lenses.

We have learnt about the refraction of light in a slab of plane faces in lessons 15 and 16. In lesson 17, we learnt about the effect of light rays passing through a triangular prism.

All of them have plane faces. They are transparent. Spherical mirrors are opaque but can reflect light rays. Lenses have a spherical shape and are transparent. So their surfaces are curved.

Types of Lenses

Let us assume that pieces are formed in the shapes shown in the figure, from a solid glass sphere.

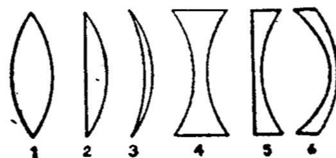


Fig. 67
Kinds of Lenses

1. Double Convex Lens
2. Plano-Convex Lens
3. Concavo-Convex Lens
4. Double Concave Lens
5. Plano-Concave Lens
6. Convexo-Concave Lens

1. That having surfaces bulged out is a **double convex lens.**

2. The one having a plane surface and a convex surface is a **plano-convex lens.**

3. The concavo-convex lens has one surface curved in and the other surface bulged out.

4. That having surfaces caved in is a double concave lens.

5. The one having a plane surface and a concave surface is a **plano-concave lens.**

6. The convexo-concave lens has one surface bulged out and the other surface caved in.

The double convex lens is thick in the middle and thin at the edges. The double concave lens is thin in the middle and thick at the edges.

Experiment

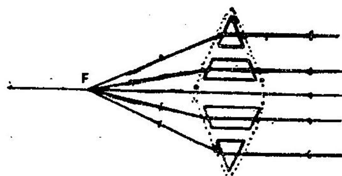


Fig. 68

Focal length of Double Convex Lens

Aim: To find the principal focus and the focal length of a double convex lens.

Apparatus required: A double convex lens, stand, screen, a film negative.

Procedure: Fix the double convex lens in the stand. Move the lens and the screen to get a clear small image of a distant tree. Adjust the screen till you get a clear image. Measure the distance between the lens and the screen.

Reflect sunlight through the lens. The rays converge at a point. Put a film negative at that point. The film catches fire in a few minutes. Measure the distance between the film and the lens. The distances in both the experiments are equal.

Definitions: The centre of the lens is called **the optic centre.**

The point of convergence of the parallel rays from the sun or a distant object by the lens is **its principal focus.**

We know that the lens is a part of a solid sphere. The centre of the sphere of which the lens is a part is known as the **centre of curvature** of the lens.

The straight line passing through the focus, the centre of curvature and the optic centre is the **principal axis.**

The distance between the focus and the optic centre is called the **focal length** of the lens.

Notes: The above definitions are like those of a concave mirror. But in a mirror, there is only one focus, one centre of curvature and one focal length. In a double convex lens, there are two (one on either side of the lens).

We are able to get the image of a distant object on the screen through a double convex lens. So it is a real image. If the object is placed within the focal length, a virtual image is got. The real image is inverted and the virtual image is erect.

Place a double convex lens on a page of your book. Lift it slowly. The letters appear big in size and then disappear. Place the lens near a lighted candle. Then move it slowly away from the flame. The flame gets enlarged gradually and disappears. But an image of the flame is formed on the other side. The quality of the image varies in different positions. You can know more about this in the ninth standard.

The Concave Lens

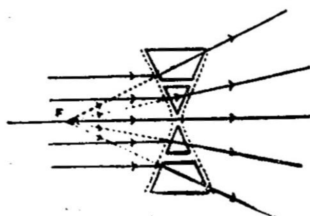


Fig. 69
Focal length of Double Concave Lens

Place a double concave lens before a lighted candle. Look at the flame through the lens. It seems much smaller and erect. The image cannot be got on a screen. It is a virtual image.

Do you remember that the emergent ray from a triangular prism always tends to deflect towards its base. We have seen it in lesson 16. Look at the figures 68 and 69. Four triangular prisms are arranged in two different ways. But in both cases, the parallel rays incident on them emerge deflected towards their bases.

Fig. 68 explains a double convex lens and Fig. 69 shows a double concave lens. We learn why a convex lens is a **converging lens** and the concave lens is a **diverging lens.**

Fig. 70 shows how the same pencil looks when seen though a convex and a concave lens.

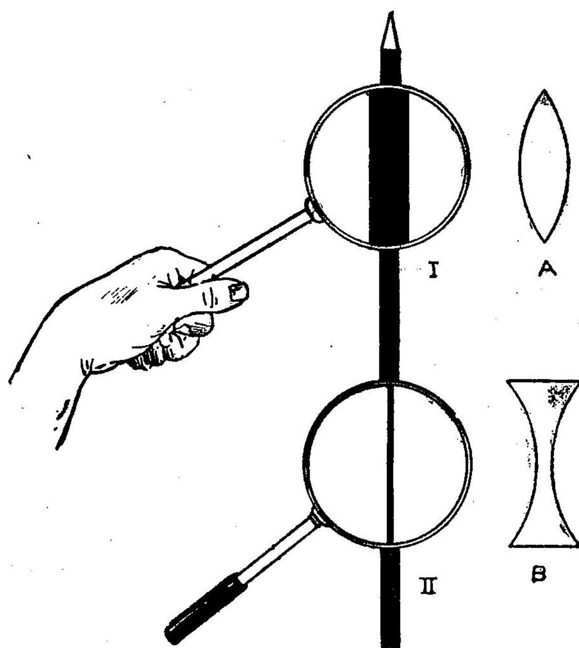


Fig. 70
A pencil seen through a convex and a concave lens

Uses of Convex Lens

The convex lens is used

1. for magnifying an objcet. Hence it is called a magnifying glass.
2. in the photo camera for getting a clear image of an object.
3. to get a clear and highly magnified image of micro organisms, in a microscope.
4. in the telescope, to look and learn about celestial and terrestrial bodies.

5. to enlarge the image of the film on the screen in a cinema theatre.

6. to rectify long sight in the eye.

The concave lens is used for rectifying short sight in the eye. It is also used in a refracting telescope.

Exercise

I. Questions

1. How would you find that the given lens is convex or concave?
2. How would you find the focal length of a double convex lens?
3. Define - principal focus, optic centre, principal axis, centre of curvature.
4. State the characteristics of the image formed of an object placed in between a convex lens and its principal focus.
5. Explain: convergent lens, divergent lens.
6. What are the uses of a convex lens?
7. Which is the lens used to rectify short sight?

II. Do you know why

1. the double convex lens is known as a simple microscope?

2. the glass on the faces of the ladies' watch and the clinical thermometer are spherical?

III. Do it Yourself

1. Take a fused bulb. Remove the cap. Fill it up with water. Put some small fish, larva of mosquito or frog in it. Reflect sunlight on it. You get a lively, big image of them on the wall.

2. Get the pair of spectacles of your friends and see through them. Learn about their defect.

19. THE EYE AND THE CAMERA

Would you like to have a photograph of yourself? Definitely yes. Suppose we want to take a group photo of all the pupils of our class. The photographer fixes his camera in front of us. He adjusts the screen and the lens to get a clear image. Then he takes off the screen and puts the film there. After some processing we get our photo.

Photographic Camera

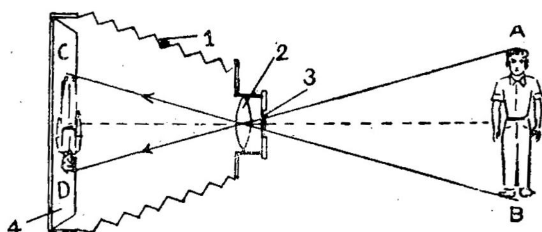


Fig. 71
The Camera

1. Bellows   2. Double Convex Lens
3. Aperture   4. Glass Screen
AB — Object   *CD* — Image

In a camera, the first part that catches our eyes is the lens. This is a double convex lens. The

image formed on the screen by this lens is small and inverted. An arrangement called the diaphragm controls the quantity of light falling on the lens. This is placed before the lens. The aperture of the camera is made larger if the outside light is low. It is made smaller if there is intense light outside. There is a ground glass screen at the back of the camera. The image is formed on this screen. The screen and the lens are connected by a folding arrangement like the bellows. This helps in getting a clear image on the screen by distending or compressing the folds. The lens is closed and the photo film is put in place of the screen. It is exposed by opening the shutter for the required time. The chemicals in the film fix the image on it. After washing and developing the film, we get the negative and then the print.

The Eye

Eyes are quite necessary for us. We know the plight of the blind. The eyes are the most useful

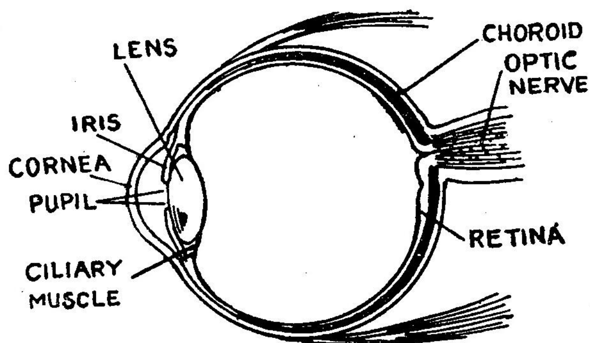


Fig. 72
Eye

of all the sensory organs. There is **a double convex lens** in the eye. It is made of several layers of trans-

parent membranes. **The cornea** is known as the window of the eye. The **iris** is the part that controls the quantity of light falling on our eyes through the pupil. It is enlarged or contracted by the muscles of the iris. The **retina** is the sensitive screen on which the image falls. The impulse is taken over to the brain by the **optic nerves.** The brain feels the actual size and position of the object though the image is inverted and smaller than the object. The focal length of the lens of the eyes is adjusted by the **ciliary muscles.**

Imagine you are reading a book in an open ground. Somebody calls you from a distance. You lift your eyes to see the person and recognise him. It is possible for the lens of the eyes, to focus on a near or a distant object immediately on seeing it. This arrangement is known as the **accommodation of the eye.** The lens becomes thicker to focus on to a near object and thinner to focus on to a distant object. The ciliary muscles contract or distend and do the adjustment.

The Eye and the Camera

Let us now compare the parts and functions of the eye and the camera.

Lens: The lenses in both the eye and the camera are double convex lenses. The lens in the camera is made of solid glass. The lens in the eye is made of several layers of transparent membranes (tissues).

Aperture-Pupil : The hole that lets in the light rays in the camera or the eye.

Diaphragm-Iris : The part that controls the quantity of light falling on the camera or the eye. It can be made larger or smaller.

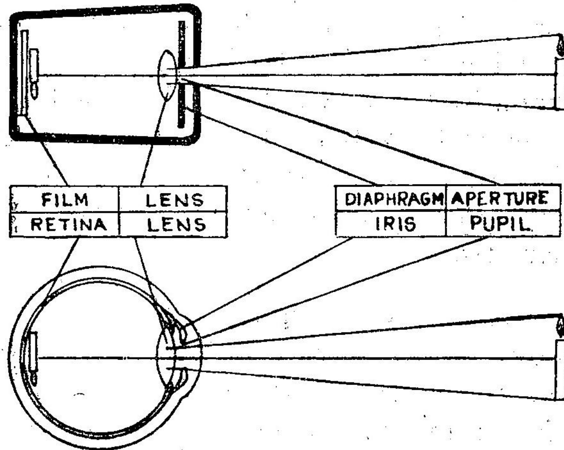


Fig. 73
The Eye and the Camera

Film-Retina : The image is formed here. Smaller inverted image is obtained in both. The film registers the image as it is obtained. But the small inverted image got on the retina is felt erect and at the actual size of the object by the brain.

Accommodation: A clear image is obtained by adjusting the distance between the lens and the film in the camera. In the eyes, the focal length of the lens is changed by making it thicker or thinner, to get a clear image.

Dark Chamber: The camera has a dark chamber because of the cabinet and a black cloth is put over

it for better effect. In the eye, the partial darkness is produced by the choroid coat.

Defects of the Eye-Rectification

Fig. 74 shows a normal eye without any defect. You have examined the spectacle lenses of your friends to know if they are convex or concave. They are worn to rectify the defects of the eye. Some of your friends may complain that the words written on the black board are not clearly seen by them. They go near the board to get a clear vision. Such a defect is known as the **short sight.** This defect is common among pupils or youngsters. But older people. find it difficult to read but they are able to see things which are at a distance. This defect is known as the **long sight.**

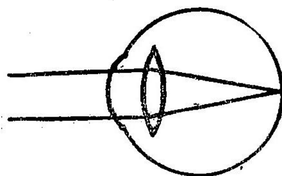


Fig. 74
Normal Eye

In the eye of those who have short-sight, the image is formed before the retina. They wear concave lenses. We know it is a divergent lens. The light rays get diverged first by the spectacle lens and so

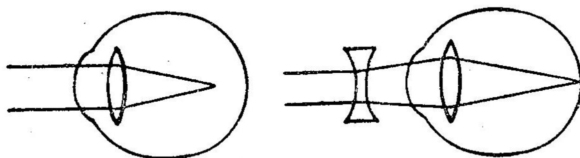


Fig. 75
Eye having Short Sight **Eye-Short Sight rectified**

the image is pushed back to the retina by the lens of the eye.

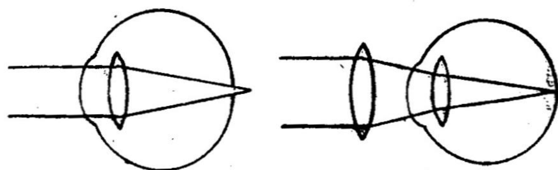


Fig. 76

Eye with Long Sight   Eye-Long Sight rectified

For those who have long sight, the image falls behind the retina. They use convex lenses. The light rays are converged once by the spectacle lens and again by the lens of the eye. The image is brought forward to the retina.

Exercise

I. Questions

1. Describe the parts of the eye and their work.
2. Describe how a photographic camera works.
3. Compare the eye and the camera.
4. What are the defects of the human eye? How are they rectified?

II. Know Yourself

1. Learn about the eye in detail in Std IX.
2. Learn from your teacher how a photograph of an object is obtained.

3. See the bifocal spectacles and learn about it.
4. The power of accommodation and the working of the pupil are clearly seen in the eyes of the cat.

III. Do it Yourself

Make a model of the camera.

IV. Explain

1. how does the eye distinguish colours?
2. it takes a longer time for us to find our seats in a cinema theatre if we go late to the matinee show. Why?

V. SOUND

20. PROPAGATION OF SOUND

While riding a bicycle, the rider keeps a thick paper or an inflated balloon on the rear wheel and makes a noise. Have you also done this? The sound is got by the vibration of the body.

Ring a cycle-bell. If it touches the handle bar, you will not hear the sweet sound of the bell. Even when a ringing bell is touched by hand, the sound stops. Sound stops when the vibrations are stopped.

When a body vibrates, sound is produced. If the vibrations are stopped, sound also ceases.

Strike a tuning fork with a rubber hammer. The prongs of the tuning fork vibrate. When the prong moves out, it compresses the air molecules in one direction and releases the air molecules on the other side. When the prong moves in, the air molecules already compressed are released and those released previously are compressed. Thus sound waves are propagated.

We know that sound waves travel through air. You have played with a match box telephone. Haven't you? Two empty match boxes are connected by a long twine. If one speaks at one end, it is clearly

heard at the other. We are able to hear the sound of a train coming at a distance, if we have our ears close to the rails. If two stones are struck under water, sound is heard above water. So, it is learnt that sound waves can travel through the media of solid, liquid and gas, like a metal, water and air.

Experiment

Aim: To show that sound waves do not travel through vacuum.

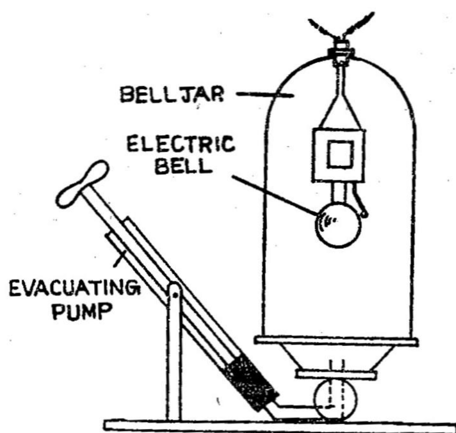


Fig. 77

Sound Waves do not travel in a Vacuum

Apparatus required: A bell jar, an electric bell, an air pump, connecting wires, a battery, key.

Procedure: Put the electric bell in the bell ar with the connecting wires outside the jar. Close the narrow mouth of the jar air tight. Place the jar on the wooden table of the air pump. Connect the wires to the terminals of a battery through a key.

Press the key. The ringing of the bell is heard clearly. Remove the air in the bell jar gradually by the air pump. The sound of the bell ringing slowly decreases and we cannot hear it finally. We can see the hammer of the bell striking the cup, but no sound is heard.

So we know that sound waves require a medium to travel and they do not pass through vacuum.

The Characterestics of Sound Waves

Sound waves move but not the medium. Sprinkle some saw dust on still water. Drop a small pebble in it. Ripples are seen moving towards the edge. The particles of saw dust move up and down but they do not move. So also, **sound waves travel through the medium but the medium does not move. The sound waves are strong at the point of origin but grow gradually weak as they move away from the source.**

Pitch

Experiment

Aim: To show that the intensity of the sound waves depend on the length of the wire.

Apparatus required: A table, two nails, a long thin string, scale pans, weights.

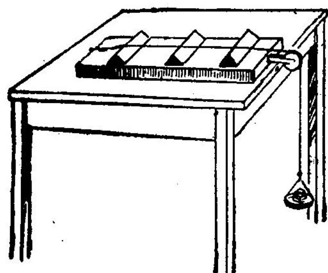


Fig. 78
Sonometer

Procedure: Fix two nails on the table near each other. Wind one end of the string to the nails and

attach the pan to the other end. Suspend the pan from the string. Put three wooden knife edges between the string and the top of the table. Put sufficient weights on the pan so that the string is under tension and straight. Excite the string between two knife edges. The distance between the knife edges is altered. Then the pitch of the sound also varies. If the length is greater, the pitch is less. If it is shorter, the pitch is greater. Pitch also depends on the thickness and tension of the wire.

Intensity

Stretch a wire and tie both the ends to two points. Excite it by a rubber hammer. The string vibrates and produces sound. If it is struck lightly, the sound is feeble. If it is heavily struck, the sound is greater. The distance through which the strings moves is known as the **amplitude** (*MN*). If the amplitude is greater, the sound produced is also greater. This is known as **intensity.**

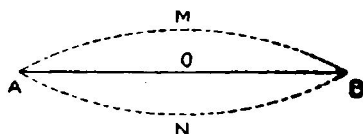


Fig. 79

MN—Amplitude

Exercise

I. Questions

1. What are amplitude, intensity and pitch?
2. Describe an experiment to show that the sound waves do not travel in vacuum.
3. How are sound waves propogated?

4. Show that the sound produced depends on the length of the string.

II. Do it Yourself

1. Make a match box telephone.
2. Make a stethoscope with a rubber tubing and a funnel. Listen to the heart beat of your friend.

III. For Thought

1. Empty vessels make much noise.
2. Sound waves travel faster in water than in air.

IV. Do you know why

1. sounds of frequency less than 30 Hertz and greater than 30,000 Hertz are not audible to the human ear.

21. MUSICAL INSTRUMENTS

We are irritated when many persons talk at a time. But we relish the sound produced by many violins simultaneously. Suppose the audience clap their hands at their will, it is noisy. When they clap their hands to beats, it is harmoneous. One is noise and the other is rhythm. Or **when the vibrations are irregular, it is noise and when they are regular, it is musical note.**

We have three kinds of musical instruments: (1) stringed instruments (2) wind instruments and (3) percussion instruments.

Stringed Instruments

The veena, the violin, the guitar etc., are some of the stringed instruments. There are strings fixed to

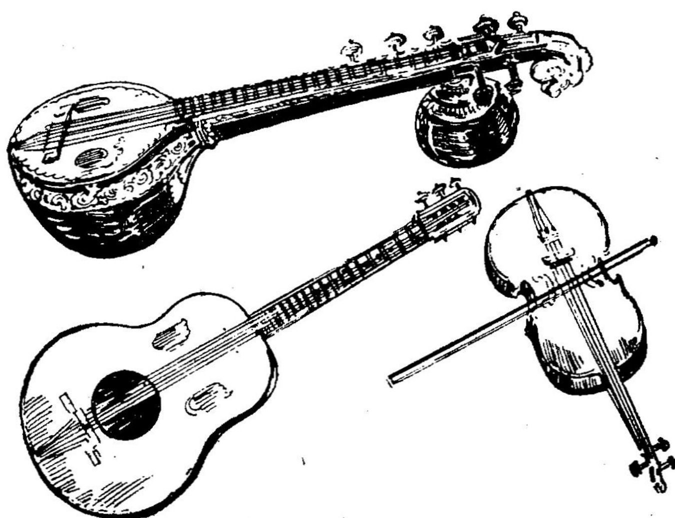


Fig. 80
Stringed Instruments

hollow wooden boxes. The thickness of the strings vary and the strings are stretched by screws. The effective vibrating length of the string is controlled by the fingers.

Wind Instruments

The flute, the nadhaswaram, and the clarionet etc. are wind instruments. The resonating column of the wind in these instruments is controlled by opening and closing the holes in them by the fingers.



Fig. 81 Wind Instrument

Percussion Instruments

The mirudhangam, the tabala, the congo drum and the ganjira are some of these instruments. Tanned hides of animals are stretched tightly over hollow wooden

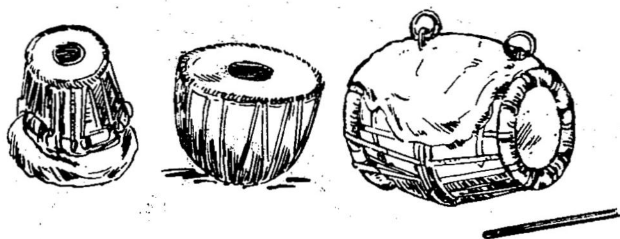


Fig. 82
Percussion Instruments

bases. When beaten by hand, finger or a stick, they make a sound. The membrane as well as the air inside vibrate and produce musical sound.

Exercise

I. Questions

1. What are the types of musical instruments?
2. Give out the difference between sound and music.
3. Give an example for each kind of musical instrument and explain how they work.

II. Do you know why

1. the wooden portion of the musical instruments are hollow?
2. the quantity of water in the various cups vary in jalatharangam?

VI. MAGNETISM AND ELECTRICITY

22. INDUCED MAGNETISM

In the sixth standard you have learnt about the magnet, the lode stone (magnetite) and how it shows north-south when suspended freely. Artificial magnets can be made and there are materials which could be magnetised. There is a magnetic field around a magnet. In a bar magnet, the intensity of magnetism is greater at the poles than at the middle. We have learnt all these things already. Now, we will learn the principles underlying the methods of magnetisation.

Induced Magnetism

Experiment

Aim: To prove that magnetism can be induced.

Apparatus required: A bar magnet, a soft iron piece, some iron nails, and a stand.

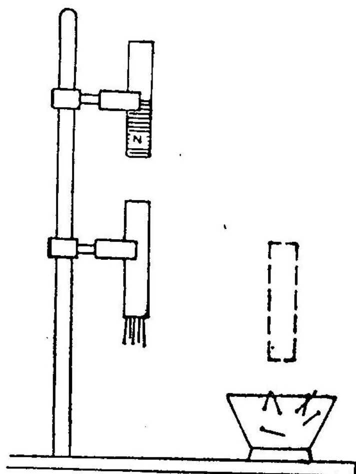


Fig. 83 Magnetic Induction

Procedure: Fix the bar magnet vertically in a stand. Fix the soft iron piece below the bar magnet.

This should also be vertical and fixed so that one end of the piece lies within the magnetic field but not touching the bar magnet. The other end of the piece attracts the iron nails brought near it. Remove the iron piece from the magnetic field. It looses its magnetism and nails fall down. The power that makes the iron piece attract the nails as long as it is in the magnetic field is known as "induced magnetism".

Experiment

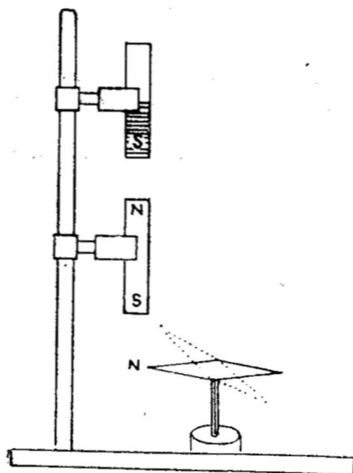


Fig. 84
Poles Induced

Aim: When magnetism is induced, that end of the soft iron piece which is nearer the south pole of the bar magnet, becomes the north pole and the other end becomes the south pole.

Apparatus required: A bar magnet, a soft iron piece, magnetic neddle, a stand.

Procedure: Fix the bar magnet in a stand vertically so that the south pole points downward. Fix a soft iron piece below the bar magnet, also vertically, so that it is within the magnetic field but not touching it.

Bring the north pole of a magnetic needle near the lower end of the soft iron piece. The needle

is attracted. So the lower end must be the south pole. If the south pole of the needle is brought near the lower end, it is repelled. By the laws of magnetism, the upper end is the north pole.

It is seen that the end of the piece of soft iron which is nearer the south pole of the bar magnet becomes the north pole. The end that is further away becomes the south pole.

Temporary Magnet

Experiment

Aim: To show that a soft iron piece is magnetised as long as it is in a magnetic field.

Apparatus required: Bar magnet, soft iron piece, nails, stand.

Procedure: Fill up a bowl with iron nails. Put a soft iron piece in it and take it out. No nail will be attracted by the soft iron piece. Fix a bar magnet in a stand, vertically. Fix the soft iron piece below the bar magnet but not touching it. Now bring the bowl of nails to the soft iron piece. Many nails cling to it. Remove the bar magnet from the stand. The nails will fall down.

There was magnetism induced in the soft iron piece as long as it was within the magnetic field. When it is taken out it loses the magnetism. So, soft iron is used to make temporary magnets.

Experiment

Aim: A soft iron piece is magnetised as long as it is in contact with a bar magnet.

Apparatus required: Bar magnet, piece of soft iron, nails.

Procedure: Make the soft iron piece touch the bar magnet. Bring some nails to the soft iron. They are attracted. Remove the bar magnet. The nails fall down.

We learn that

1. Magnetism is induced in a material, as long as it is in the magnetic field.
2. The nearer end becomes the opposite pole and the further end becomes the like pole.
3. Magnetism is temporarily established when the soft iron piece is either touching the bar magnet or within the magnetic field.
4. The intensity of the induced magnetism is proportional to its nearness to the bar magnet.
5. So, soft iron pieces are used for making temporary magnets.

Permanent Magnets

Experiment

Aim: To show that steel can retain induced magnetism.

Apparatus required: Steel rod, bar magnet, iron nails.

Procedure: Place the steel rod touching the bar magnet. Bring some nails to the steel rod. They are attracted. Remove the bar magnet. The nails

fall down but not completely. Still some cling to the steel rod.

It is seen that (1) magnetism is induced in the steel rod when it is either in contact with a bar magnet or when it is in the magnetic field.

(2) Steel retains some magnetism even after the bar magnet is removed from it and not in contact.

So permanent magnets are made of steel.

Very powerful permanent magnets are Alnico magnets. They are made of an alloy of aluminium (*Al*), nickel (*Ni*) and cobalt (*Co*).

Exercise

Questions

I. Answer briefly

1. What happens to a soft iron piece when it is kept in a magnetic field?
2. How would you prepare a temporary magnet?
3. How do you determine the intensity of temporary magnetism?

II. Answer in detail

1. Describe an experiment to show that magnetism can be induced.

III. Fill up the blank

1. That end of the soft iron, which is nearer the south pole of a bar magnet becomes

2. Steel is used in making ———————— magnets.

3. The three metals in the alnico (magnets) are ————, ———— and

IV. Know Yourself

Powerful temporary magnets are used in harbours, and workshops using metals.

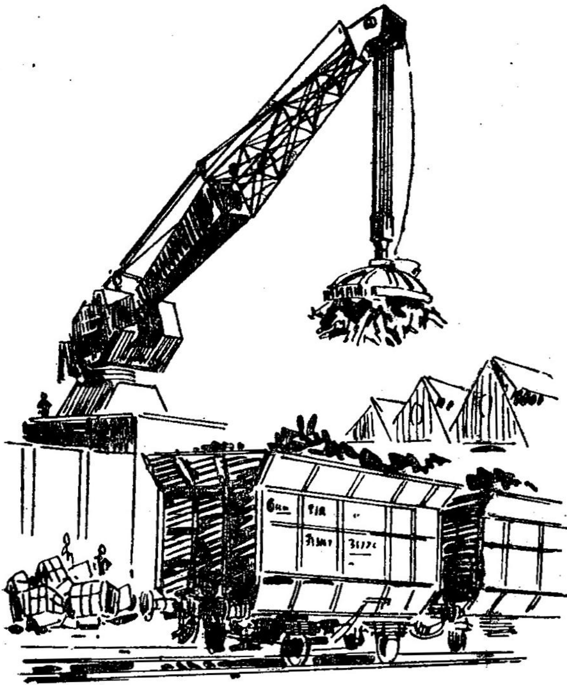


Fig. 85
Electromagnet

23. STATIC ELECTRICITY

Part and comb your hair with a plastic or ebonite comb, when it is dry. Tear a piece of paper into very small bits. Touch them with the comb. What do you observe?

Roll on an easy chair or a cot with a nylon cloth. What happens when your bare limbs move on the cloth?

How do you feel when you remove anything from or put in anything into a plastic bag?

The paper bits stick to the comb. The hairs on the bare limbs experience a shiver and the hairs are raised.

The existence of static electricity was proved long back. Around 600 B.C., the Greek philosopher **Thales** found that **amber**, a resinous material, attracted pieces of paper, straw or cork, when rubbed with wool or fur or silk. **William Gilbert**, an English doctor performed the same experiment with glass, amber, ebonite and vulcanite and obtained the same results. Let us also do the same experiment.

Note: It is essential to wear gloves while doing the experiment.

Experiment

Aim: To verify the existence of static electricity.

Apparatus required: A glass rod, an ebonite rod, a dry piece of woollen cloth, a dry piece of silk cloth, small paper bits.

Procedure: Take a silk cloth in one hand. Hold a glass rod by the other hand. Hold the glass rod firmly and rub it with a silk cloth in one direction. After rubbing it several times hold the glass rod on the pieces of paper. They stick to the rod. If the silk cloth is taken near the pieces of paper, they stick to the silk cloth also.

Rub the ebonite rod with a piece of woollen cloth. The ebonite rod and the woollen piece attract the paper pieces if they are taken near the paper pieces.

The force that makes the ebonite rod, the glass rod, the woollen piece, or the silk piece to attract pieces of paper is known as static electricity. As the results are obtained by rubbing it is known as charging by friction.

Types of Charges

Experiment

Aim: To note the types of charges in static electricity.

Apparatus required: Two ebonite rods, two glass rods, a piece of silk cloth, a piece of woollen cloth, pieces of paper, stand.

Procedure: Rub the glass rods in the silk cloth and charge them separately Rub the ebonite rods with the woollen piece and charge them separately.

Suspend one ebonite rod from a stand with a piece of twine. Take the other ebonite rod near it The suspended rod is repelled.

Suspend one glass rod from a stand with a piece of twine. Take the other glass rod near it. The suspended rod is repelled.

Suspend one ebonite rod from the stand. Take the glass rod near it. Note that they attract each other.

We learn the following facts from these experiments:

1. The charge in the ebonite rod is different from the charge in the glass rod.
2. Rods with the same kind of charge repel each other.
3. Rods with two different types of charges attract each other.

We know that there are two kinds of charges. The positive charge is denoted by a + sign and the negative charge by—sign. The glass rod rubbed with silk is positively charged and the ebonite rod is charged negatively.

Experiment

Aim: To know the type of the charges in silk and wool.

Apparatus required: Silk cloth, woollen cloth, two ebonite rods, two glass rods, paper bits and a stand.

Procedure: Charge the glass rods separately by rubbing them with the silk cloth. Charge the ebonite rods separately with the woollen cloth. Test them

separately for charges by taking them near small pieces of paper. Test the woollen and silk cloth also for charge in the same way.

Suspend one ebonite rod and one glass rod separately from the hangers by a silk thread. We know that the glass rod is positively charged and the ebonite rod is negatively charged.

Take the silk cloth near the glass rod. They attract.

Take the woollen cloth near the ebonite rod. They attract each other.

The glass rod repels the woollen cloth and the ebonite rod repels the silk cloth.

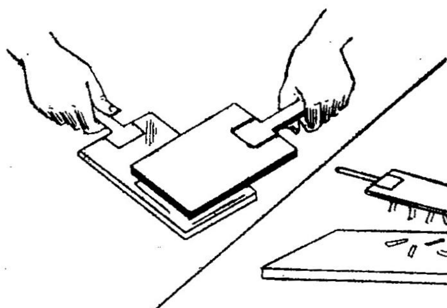
We know from the above that

1. The glass rod is positively charged
2. The ebonite rod is negatively charged.
3. Things charged alike repel each other and
4. Things with opposite charges attract each other.

In the above experiment, the silk cloth is repelled by the ebonite rod and is attracted by the glass rod. Hence it is negatively charged. The woollen cloth is repelled by the glass rod and is attracted by the ebonite rod. So it has positive charge.

Substance rubbed	Type of charge
Glass rod Ebonite rod	Postive (+) Negative (—)
Substance used for rubbing	Type of Charge
Silk cloth Woollen cloth	Negative (—) Postive (+)

Experiment



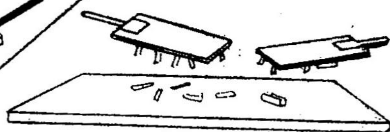


Fig. 86
Rubbing Glass and Leather Faces

Fig. 87
Static Electricity

Aim: To show that the bodies which are rubbed and those which are used to rub get equally charged.

Apparatus required: A metal plate covered by leather on one side, another metal plate covered by glass on one side, pieces of paper.

Procedure: Take the two metal plates. They have wooden handles (Why?) Put the glass surface and the leather surface together, rub them in the same direction. Take them separately near pieces of paper. The paper bits stick to them. So we know that they are charged.

Remove the paper bits from the plates. Hold them together so that the glass and leather faces touch each other. Take the plates in this position to the paper bits. They are not attracted.

First the plates were charged. But now they do not attract the pieces of paper. What happened to the charge? Have the plates lost the charge? It is seen that the plates had equal and opposite charges and when they are close together, they are neutralised.

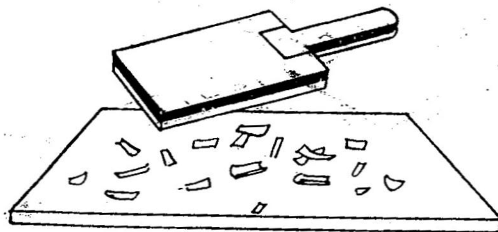


Fig. 88
Neutralising Static Electricity

Explanation: All the materials in nature are electrically charged. There are positive charges (**Protons**) and negative charges (**Electrons**). They are equal in number and have equal amount of charges. Hence the material is electrically neutral. When the glass rod is rubbed

on the silk cloth, it loses some of the electrons. The silk cloth gains them. So the number of electrons increases in the silk cloth. The number of electrons are reduced in the glass rod. So the glass rod becomes positively charged and the silk cloth becomes negatively charged.

Exercise

I. Questions

Give Short Answers

1. What will happen if two rods of the same type of charge are brought together?
2. Explain how things in nature are electrically neutral.
3. The substance that is used for rubbing and the substance that is rubbed have opposite charges. Explain.

Answer the Following

1. How would you prove the existence of static electricity using a glass rod?
2. Explain the effect of electrical charges in the silk cloth and the woollen piece.
3. Prove that the charges are equal in amount in the substance that rubbed and the substance that is rubbed.

II. Fill up the blanks

1. An amber rod rubbed on a woollen cloth is ———— charged.

2. A charged glass rod and a charged ebonite rod, when brought near ———— each other

24. MEASURING STATIC ELECTRICITY

We learnt about the property of static electricity in the previous lesson. Let us now learn about the methods of producing and measuring the quantity of the static electricity.

Charging by Conduction: A material is charged by making it come in contact with another material which is already charged.

Experiment

Aim: To show that a material can be charged by conduction.

Apparatus required: A paper roll, an ebonite rod, a glass rod, silk thread, stand.

Procedure: Take a positively charged glass rod and a negatively charged ebonite rod.

Suspend the paper roll horizontally by a silk thread from the stand. Touch the roll by the glass rod. Before it touches the paper roll, the roll is attracted towards the glass rod and they come in contact. After a few seconds, the roll separates from the rod. If the rod is now taken near the roll, it is repelled. This shows that the paper roll is positively charged.

If some paper bits are taken near the paper roll, they are attracted, proving the existence of electrical charge in the roll. Take the negatively charged ebonite rod near the roll. It is drawn (attr-acted) towards the ebonite rod. This shows that the paper roll is positively charged.

We now learn that a body gets the same kind of charge when it comes into contact with another body, already charged. This is known as charging by conduction (contact).

Charging by Induction: There is an electrostatic field around a charged body. In the previous experiment, the paper roll is first attracted towards the glass rod. After they come into contact with each other, the paper roll acquires a positive charge and so it is repelled by the glass rod. The negatively charged ebonite rod attracts the paper roll. The repulsion or the attraction takes places even when the charged bodies are near each other, before contact. It is the effect of the induction or the field around the charged bodies.

Experiment

Aim: To show that the two ends of a charged rod have opposite charges.

Apparatus required: A paper roll, positively charged glass rod, another body to be charged, silk thread, stand, a wooden stand.

Procedure: Let the paper roll be negatively charged. Suspend the paper roll from the stand

by the silk thread. Place the body (another rod) horizontally on a wooden stand. Take the positively charged glass rod near the horizontal rod, without touching it. Now bring the paper roll near that end of the horizontal rod, which is already charged by induction by the glass rod. The paper roll is repelled. Take the paper roll to the other end of the rod. It is attracted.

This shows that the positively charged glass rod has induced positive charge on the farther end of the other rod and negative charge in the nearer end.

Generally, that end of the body to be charged near the charged body acquires an opposite charge by induction. The other end takes the same kind of charge.

Electroscopes

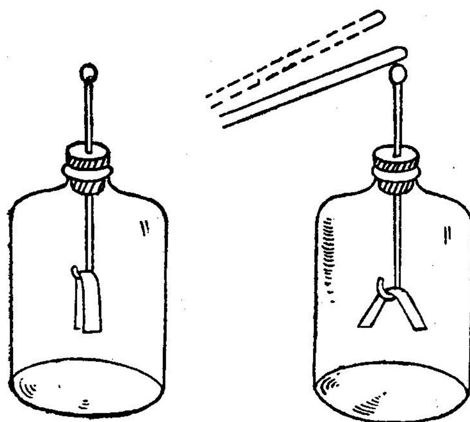


Fig. 89
Electroscope

An electroscope is an instrument to detect the presence of the electrostatic charge in a body and to compare the charges of different charged bodies.

Experiment

Aim: To learn about the electroscope and how it works.

Apparatus required: A simple electroscope, charged glass rod, Λ shaped paper bit.

Procedure: Cut a paper bit in Λ shape. A vertical glass stand is fixed on a wooden base. A piece of copper wire is bent at both ends and is rolled on the top of the glass stand, as shown in Fig. 89. Place the paper bit on one end of the wire, and the ends of the paper bit are close to each other. This is a simple electroscope.

Take the positively charged glass rod and touch that end of the copper wire, which does not have the paper bit. The ends of the paper bit open up. The degree of divergence of the paper bit depends on the intensity of the charge in the glass rod.

If the experiment is performed with a negatively charged ebonite rod, the same results are obtained. The ends of the paper bit open up.

From this we know that **the ends of the paper bit acquire the same kind of charge as that of the charged body.** So they repel each other.

Gold Leaf Electroscopes

The Gold leaf electroscope works on the principle explained in the previous paragraph.

Description — Gold Leaf Electroscope

A metal rod is inserted into a glass bottle through a one holed rubber cork. The lower end of the rod is inside the bottle and the upper end is outside. The upper end has a metallic knob and the lower end has two gold leaves as in the Fig. 89.

How it works

Touch the metallic knob by the charged body. The leaves at the lower end diverge. The degree of divergence depends on the strength of the charge.

The leaves stay divergent, as long as the charge is on the electroscope. So after finding out the strength of the charge, the metallic rod is earthed by touching it with our bare hand or by a piece of wire touching the earth. Now the leaves collapse, showing the absence of any charge.

Among those who discovered static electricity **Benjamin Franklin** was the pioneer. He was born to poor parents in Boston (in Philedelphia in North America. This harbour town played an important role in the freedom struggle of America). His father was a vendor and his brother had a printing press. He was a great reader, and spent most of his earnings on books. He wrote humourous essays also. He went to London and worked as a compositor. He came back to America and started his own printing press in 1706. The Pensilvanian Gazette and the Almanac were two of his famous publications. He was the first to use lead for making types. He founded a mobile library also.

Other gadgets made by him are 1. the aid for fast swimming 2. smokeless oven 3. the rocking chair and 4. spectacles for defective eyes.

Scientific Theories of Benjamin Franklin

1. "All substances have certain quantity of electricity. As long as this amount remains, it is neutral. This quanity may be increased or decreased. When it is increased or decreased, it is said to be charged. When it is increased, the substance is said to be positively charged. When it is decreased, it is negatively charged."

This concept agrees with the present theory of charge in the quantum of electrons in a body. But Franklin considered electricity as some thing like a liquid.

2. In the days of Benjamin, scientists thought that friction produced electricity, like it produced heat. He proved that this idea was wrong. He said that when a glass rod was rubbed by a piece of silk, there was an increase of electricity in the glass rod and a decrease in the piece of silk. This increase and decrease caused the glass rod to be positively charged and the piece of silk to be negatively charged. The electricity lost by the piece of silk was equal to that gained by the glass rod.

3. His experiment with a kite on a stormy day in 1752 is world famous. He made a big kite with very light sticks and silk cloth. He fixed a long, sharp and thin wire on one corner of the kite, and connected it to a long roll of thread. He

also attached a piece of silk to the other end of the thread and tied a key where the piece of silk and the thread joined. He allowed the kite to fly high on a stormy day, when there was thunder and rain. He took shelter under a tower so that the piece of silk did not become wet. When there was lightning, he brought his fist near the key. There was spark from the key that passed on to his knuckles and he received a heavy shock. He proved that the lightning was the result of electricity in the clouds and that it could be passed on to the earth. He introduced the lighting arrestors in tall buildings and prevented damage to the buildings from the electric charge. He passed away in 1790.

Exercise

I. Questions

Answer briefly

1. What are the methods of charging a body?
2. What are the kinds of charges produced on the ends of a body, while it is charged by induction?
3. How did Franklin get the sparks on his knuckles?

II. Describe

1. how a body is charged by conduction.
2. the process of charging by induction.
3. the gold leaf electroscope and how it works.

4. the lightning experiment by Benjamin Franklin and its results.
5. the life history of Benjamin Franklin and his discoveries.

III. Fill up the blanks

1. The leaves of the gold leaf electroscope ———————— when a charged body is put on it.
2. Lightning is ————————
3. There is an ———————— round a charged body.

Know Yourself

1. The electrostatic charge can be accumulated. The power is high. **Abbe Nellot** of Italy performed tricks in 1740, like firing a cannon. He made a few hundred priest join hands. When the first priest touched a charged Leyden jar, all of them received a heavy shock. The capacitors are based on this principle.

2. Petrol vans have an iron chain attached to its rear, which touches the earth. If charges are produced by friction and by electrostatic induction, sparks may be produced and there may be a fire accident. The chain conducts such charges to the earth.

3. When dry, our hairs do not stay together even when combed. While combing, they get the same charge and so remain repelled. When wet, the charges are leaked and so stay together.

25. CURRENT ELECTRICITY—PRIMARY CELLS

We learnt in the previous lesson about the static electricity and that it can be stored. We know about the intensity of the electricity thus stored. It is not possible to conduct static electricity through wires. The electrical energy capable of being conducted through wires is known as current electricity.

We now explain the properties of electricity through "Electron Theory". Benjamin Franklin thought of electricity as a liquid that flowed. But at present electrons are considered as seperate particles.

All substances are made of molecules. Each molecule is made of atoms. It was thought that atoms are very small and indivisible. But scientists like **J. J. Thomson** and **Rutherford**, explained the real structure of atoms and it was proved later on that they can be split.

The centre part of the atom is the **nucleus**. The nucleus contains positively charged **protons** and **neutrons** that are electrically neutral. The negatively charged **electrons** go round the nucleus in their orbits, like the planets of the solar family. The atomic weight of the substance is determined by the weight of the nucleus (protons+neutrons) in it. The substance or element is normally neutral because the number of electrons and protons are equal. The electrons can jump from one orbit to another

Recollect how the charge gained by the silk cloth and the glass rod was explained in the previous lesson.

Flow of Current Electricity

According to the **'Electron theory'**, the flow of electrons in a medium is current. Metals contain some uncontrolled electrons. When electricity is made to pass through them, the uncontrolled electrons begin to flow, which is known as current. But in the glass rod or ebonite rod, there is no such uncontrolled electrons. Hence current through them is not possible.

Experiment

Aim: To prove that metallic wire conducts electricity.

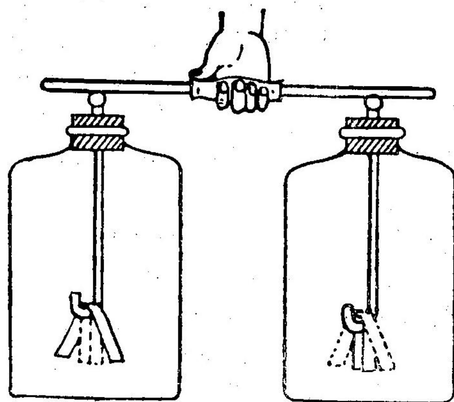


Fig. 90
Metal conducts Electricity

Apparatus required: Two electroscopes, a metal wire with an ebonite handle at the centre.

Procedure: Charge an electroscope negatively. The leaves diverge. Place the other electroscope

near this and touch the knobs of the two electroscopes by the ends of the wire. The leaves of the uncharged electroscope diverge and those of the charged electroscope collapse, gradually. This shows that **electrical charge is conducted from the charged to the uncharged electroscope through the wire.**

The leaves of both the electroscopes collapse showing that they have lost the charge. Static electricity is not stable for a long time. But as long as the wire is in contact with electrically charged body, the flow of electricity continues.

Primary Cells

Primary cells are those which produce electricity by chemical action, and give a flow of it through the wire. The first primary cell was invented by **Volta**, an Italian scientist in 1795 A.D. and is called the Voltaic Cell.

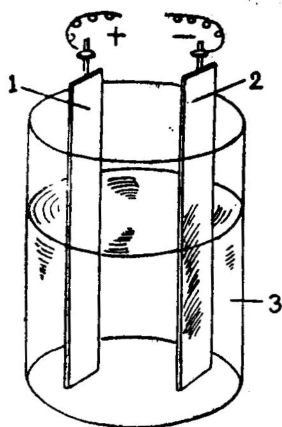


Fig. 91
Voltaic Cell

1. Copper Plate
2. Zinc Sheet
3. Dilute Sulphuric Acid

Voltaic Cell

Dilute sulphuric acid is kept in a glass vessel. One **copper** plate and one **zinc** plate are placed in the vessel side by side, without touching each other. The free ends of the wire from the above metal plates are connected to a bulb. The bulb glows.

The copper plate is +ve and is called the anode. The zinc plate is —ve and is called **cathode.** The sulphuric acid in the vessel is known as the **exciting liquid.** Chemical action takes place between the copper plate, zinc plate and the acid. The copper plate is positively charged. There is a flow of electricity (electrons) from the copper plate to the zinc plate, through the wire. Hence the bulb glows.

Electrons flow from the zinc plate to the copper plate through the acid. The excess of electrons thus obtained, flow from the copper plate to the zinc plate through the wire. As long as the chemical action continues in the acid, the current continues to flow through the wire.

The two defects of the Voltaic Cell are (1) **Local Action** and (2) **Polarisation.**

Local Action

Pure zinc reacts chemically with sulphuric acid and produces electricity. The zinc plate used in the Volatic cell may contain impurities like carbon and iron particles. They act as anodes while the zinc plate is the cathode. So miniature cells are established in the main cell and flow of current is reduced. This defect is local action.

A few drops of mercury are taken by the sponge and the zinc plate is coated with mercury. The zinc and mercury combine to form zinc amalgam. The coating prevents the impurities from reacting and exposes the zinc portion only for chemical action. Thus the defect is controlled.

Polarisation

Zinc reacts with sulphuric acid and evolves hydrogen. The hydrogen bubbles accumulate at the copper plate, forming a coating over it. The effective area of reaction is reduced. So the flow of current stops. This defect is known as polarisation.

Some chemical substances like manganese di-oxide and copper sulphate oxidise the hydrogen to convert it to water. The substances are called **depolarisers.** By using them the defect of polarisation is rectified.

The Volatic cells has an e.m.f. (voltage) of 1·06 volts.

Primary Cells

Primary Cells like the Daniel cell and the Leclanche cell were devised after the defects in the Voltaic cell were rectified.

Daniel Cell

It was devised in 1836 B. C.

Copper sulphate solution is kept in a copper vessel. An insulated wire is connected to the vessel. A porous pot is kept at the middle of the vessel. It contains dilute sulphuric acid. In the porous pot, a zinc rod is placed, and the rod is coated with mercury. An insulated wire is connected to the top end of the zinc rod. A plate with many holes is put on top of the copper sulphate solution containing copper sulphate crystals. It is in contact with

the solution. The free ends of the wire are connected to a bulb.

The **copper vessel** is the anode. The **zinc rod** is the cathode. **Dilute sulphuric acid** is the exciting liquid. **Copper sulphate** acts as depolariser. The zinc rod reacts with the acid and is negatively charged. Current flows through the wire and the bulb glows. The hydrogen formed during the reaction is oxidised by the copper sulphate. The copper sulphate solution gets diluted. To keep the density of the solution at an optimum level, copper sulphate crystals are placed in the many holed plate. The zinc rod being coated with mercury prevents local action.

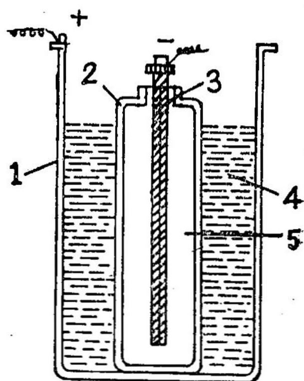


Fig. 92
Daniel Cell

1. Copper Vessel (Anode)
2. Porous Pot
3. Zinc Rod (Cathode)
4. Copper Sulphate Solution
5. Diliute Sulphuric Acid

Note: The e.m.f. (voltage) here is 1·08 volts. This cell gives a continuous flow of current. When the cell is not in use, the porous pot is taken out. If kept in, the copper sulphate and the sulphuric acid react and copper will be deposited on the zinc rod.

Leclanche Cell

Ammonium chloride solution is kept in a glass vessel. At the centre of the vessel, a porous pot is placed. A carbon rod is put inside the pot and

a zinc rod is taken in the glass vessel outside the pot. A mixture of manganese-di-oxide and carbon is provided around the zinc rod in powder form. The mouth of the porous pot is covered by pitch.

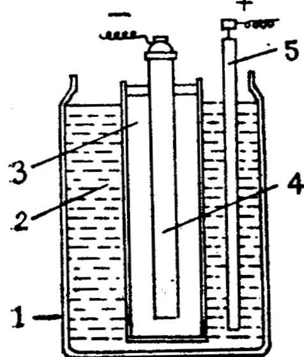


Fig. 93

Leclanche Cell

1. Glass Vessel
2. Ammonium Chloride Solution
3. Manganese-di-oxide and Carbon in a porous pot
4. Zinc Rod
5. Carbon Rod

In this cell, the anode is the **carbon rod**. The cathode is the **zinc rod**. The **manganese-di-oxide** mixture acts as depolariser. The **ammonium chloride** solution is the exciting liquid. The zinc rod reacts with the ammonium chloride and is negatively charged. There is a flow of electricity in the wire and the bulb glows. Hydrogen formed diffuses into the porous pot and gets oxidised.

The process of oxidation is slow in this cell. Though the voltage is 1·5 volts, it can be used only intermittently. So this cell is used in telegraphy and for the electric bell.

Dry Cell

This an improved form of the Leclanche cell. Here the ammonium chloride solution is provided in the paste form. A zinc cylinder is filled with the paste of ammonium chloride, zinc chloride and glyc-

erene, around a canvas bag kept at the centre. In the canvas a carbon rod is placed at the centre around which carbon powder and manganese - di - oxide are filled There is a brass cover over the carbon rod. The top of the cylinder is covered by pitch.

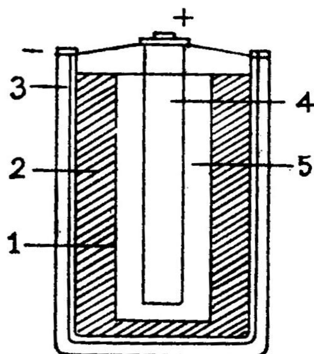


Fig. 94
Dry Cell

1. Canvas Bag
2. Ammonium Chloride Paste
3. Zinc Cylinder
4. Carbon rod
5. Manganese-di-oxide-mixture

The **zinc cylinder** itself is the cathode. The **carbon rod** is the anode. The **paste of ammonium chloride** is the exciting liquid. The mixture of **carbon** and **manganese-di-oxide** is the depolariser. When the circuit is complete, the zinc cylinder becomes negatively charged due to chemical action with ammonium chloride. The bulb glows because of the flow of electricity. The paste and zinc chloride must not be completely dry for the cell to work. So glycerene is added. The hydrogen formed is oxidised by the manganese-di-oxide.

This cell is intermittently used in torch, transistor radio, telegraphy etc. The voltage is 1·5 volts.

To Summarise

Cell	Anode	Cathode	Exciting liquid	Depo-lariser
Voltaic	copper plate	zinc plate	dilute sulphuric acid	copper sulphate solution
Daniel	copper vessel	zinc plate	dilute sulphuric acid	copper sulphate solution
Lecl-anche	carbon rod	zinc rod	ammo-nium chloride solution	mang anese-di-oxide—carbon mixture
Dry	carbon rod	zinc cylinder	ammonium chloride with zinc chloride & glycerene	mang-anese di-oxide carbon mixture

Exercise

I. Questions

Answer in one or two sentences:

1. What happens to the hydrogen formed during the working of a cell?

2. What is the depolariser in a Leclanche cell?

3. What is the function of zinc chloride in a dry cell?
4. What is a molecule?

II. Answer the following questions:

1. Explain the 'Electron Theory'
2. Describe a voltaic cell and its defects.
3. How is local action prevented?
4. Describe a Daniel cell and explain how it works.
5. The Daniel cell is an improvement on the voltaic cell. How?
6. How does a Leclanche cell work?
7. Point out the differences between a Leclanche cell and a Dry cell.
8. How does a Dry cell work?
9. Why is a Leclanche cell used intermittently?
10. How is polarisation remedied?

III. Know Yourself

1. The primary cells produce direct current (D.C.) What we use in our houses is alternating current (A.C.)
2. The battery is a combination of cells.

26. MAGNETIC EFFECT OF ELECTRICITY

You know about ordinary magnets. You have played with one by drawing iron pieces. Do you know that a solenoid made of insulated wire can

act as a magnet? As long as there is flow of electricity, it acts as a magnet. Electricity has magnetic effects also.

Oerstead, the Danish scientist proved in 1819 A.D. that electricity has magnetic effect. Till then it was believed that magnetism and electricity were independent and one had no effect on the other.

Experiment

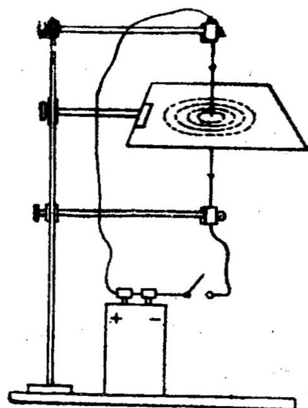


Fig. 95

Electric Wire sets a Magnetric Field

Aim: To show that a magnetic field is set around an insulated wire, when a current flows through it.

Apparatus required: A stand, a thick cardboard with a hole at the centre, thick insulated wire, connecting wires, a primary cell, key, iron filings.

Procedure: Fix the cardboard horizontally in a stand. Insert the thick insulated wire though the hole vertically. Connect the ends of the wire, to the primary cell by connecting wires, through a key (the key is a dveise to close or open the electric circuit). Sprinkle some iron filings on the cardboard around the wire. Press the key and complete the circuit. Tap the cardboard gently. The iron filings arrange themselves in concentric circles with the wire at their centre. Such a formation is possible

in a magnetic field only. Hence we know that a magnetic field has been set around the wire carrying current. The magnetic field is set in a plane perpendicular to the plane of the wire.

Electro magnets work on this principle.

Experiment

Aim: To show that when current flows through an insulated wire solenoid, the solenoid acts as a magnet.

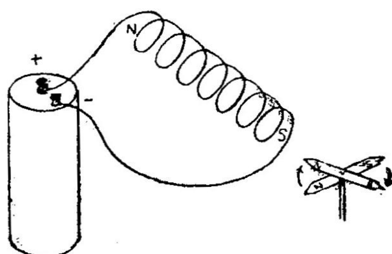


Fig. 96
Solenoid as a Magnet

Apparatus Required: Insulated wire, a magnetic needle in a stand, a primary cell, key, soft iron nails.

Procedure: Wind an insulated wire on a pencil and remove the pencil. It is formed like a spring. This is called **a solenoid**. Connect the ends of the wire to a primary cell through a key. Place the magnetic needle near one end of the solenoid and also at its central axis. Press the key and there is a flow of current in the wire solenoid. The magnetic needle is deflected. Disconnect the key and stop the flow. The magnetic needle comes to its original position.

Insert the soft iron needle inside the solenoid. Press the key. The magnetic needle is deflected with more force than before. Disconnect the circuit

and the magnetic needle comes back to the original position facing north-south.

We know now that the solenoid acts as a magnet. The magnetic effect is greater when the soft iron piece is inserted in the solenoid. The soft iron piece is known as **the core.**

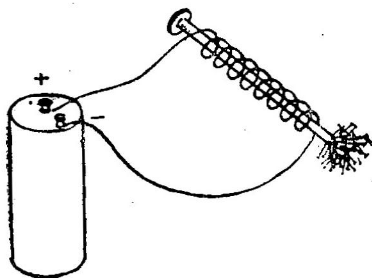


Fig. 97
Soft Iron Core

In lesson 22, we learnt that soft iron is magnetised by magnetic induction and loses its magnetism immediately when the induction is stopped. But, a steel piece retains a small quantity of magnetism even after the induction is stopped. Further **it is seen that with induction the soft iron piece becomes a powerful magnet than the steel piece.** So soft iron is used in making temporary magnets.

When identical pieces of steel and soft iron are placed in solenoids of equal capacity, and equal quantity of current is passed through them, then,

1. the magnetic attraction is greater in the soft iron than in steel. So **the permeability** of soft iron is greater than steel.

2. The pieces are magnetised. When the current is stopped soft iron loses the magnetism completely.

But steel retains a small quantity of magnetic energy. So, the **retentivity** of soft iron is less than that of steel.

Electric Bell

A horse shoe electromagnet is fixed on a wooden plank. Thin wire is wound on the electromagnet. A soft iron **armature** is fixed near the poles of the horse shoe magnet. The lower end of the armature is attached to a hammer like device. The hammer strikes a gong when it moves. A spring is attached to the soft iron armature touching a screw.

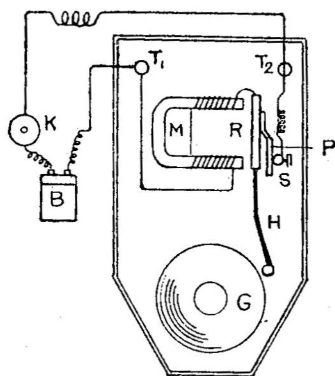


Fig. 98
Electric Bell

M — Magnet
R — Armature
P — Pointer
S — Screw
H — Hammer
G — Gong
K — Key
B — Battery
T_1 T_3 — Terminals

One terminal of the primary cell is connected to the armature by a connecting wire that connects the windings on the elctromagnet also. The other terminal is connected to the screw through a key. All the connecting wires are connected to two terminals on the board.

Normally, the spring will be touching the screw. The circuit is closed when the key is pressed. The horse shoe piece of soft iron becomes an electromagnet. It attracts the armature towards it. The

hammer connected to the armature strikes the gong and there is sound. At the same time the spring is detached from the screw. So the circuit is broken. The electromagnet loses its magnetism. The armature breaks from the magnet and returns to its original position by the action of the spring. The spring touches the screw restoring the electrical circuit. Thus the cycle is repeated many times and the bell is heard intermittently.

Morse Key and Sounder

You would have gone to a post office and seen the telegraphic devise. Both the transmitter and

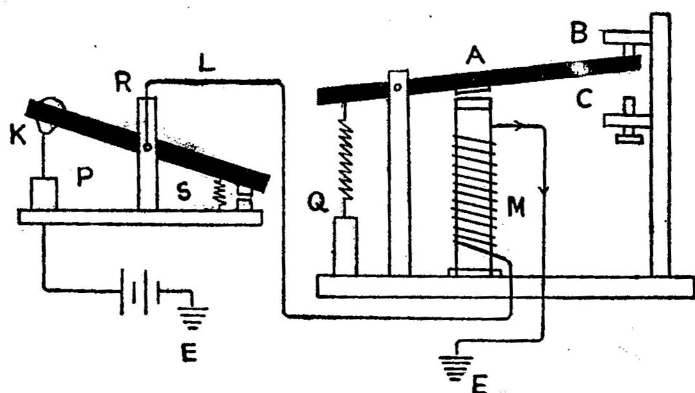


Fig. 99

Morse Key   Morese Sounder

K—Key   *P*—Pointer   *R*, *A*—Lever
S, *Q*—Springs   *L*—Line (wire) Electro
M—Magnet   *P*, *C*—Serews

the receiver are connected. The transmitter is known as the 'Morse Key' and the receiver is called the

'Morse-Sounder'. **Morse,** an American scientist invented the devise and the code system of sending messages. Hence the name. There is a key. It is a rod with a metal end that touches another metal end when pressed. The lower part is a horizontal bar of a bad conductor. The upper part consists of a rod connected to a metal bar at the centre. The rear end of the upper part is connected to the rear end of the lower part by a spring. The metal ends of both the upper and the lower part do not touch each other normally. The key is connected to one terminal of a primary cell. The other terminal is **earthed.**

The Morse sounder consists of an electromagnet and a lever above the magnet. There is a soft iron piece in the lever just above the magnet. The end of the lever is fixed to a spring from the lower part and the other end lies between two screws. One end of the solenoid over the magnet is connected to the key by connecting wires, and the other end is earthed.

The key is pressed. The metal parts touch each other and the circuit is completed. The electromagnet in the sounder is magnestised and it attracts the soft iron piece. The lever strikes the lever screw and makes a short 'click' sound. When the key is released, the eletromagnet loses its magnetism and releases the lever. Then the lever strikes the upper screw and makes a 'clack' sound.

Morse Code

The Morse code consists of 'clicks' given by dots and 'clacks' by dashes. Morse gave codes of

dots and dashes for all the 26 English alphabets and also for number 0 and numbers 1 to 9.

A .—	B —...	C —.—.	D —..
E .	F ..—.	G ——.	H ....
I ..	J .———	K —.—	L .—..
M ——	N —.	O ———	P .——.
Q ——.—	R .—.	S ...	T —
U ..—	V ...—	W .——	X —..—
Y —.——	Z ——..		

1 .————	2 ..———	3 ...——
4 ....—	5	6 —....
7 —— ..	8 ———..	9 ————
0 —————		

Signals are sent on Morse code by wireless and by using shutter over powerful lamps. These are mostly used in ships.

Exercise

I. Questions

Answer is one or two sentences:

1. How would you know that a magnetic field is set around a wire carrying current?
2. Give two reasons for soft iron being used to make temporary magnets.
3. In which part of the electric bell is soft iron used?
4. How would you increase the intensity of magnetism in a solenoid carrying current?

II. Answer the following questions in detail:

1. Describe an experiment to show that a magnetic field is set around a wire carrying current.

2. Give out the differences between a soft iron piece and a steel piece in magnetisation.

3. Describe an electric bell and its working.

4. Describe how a Morse Key and sounder work.

III. Fill up the Blanks

1. ——— discovered the magnetic effect of electricity.

2. The devise used for completing or disconnecting an electrical circuit is the ———.

3. The plane of the magnetic field around a wire carrying current is ——— to the plane of the wire.

IV. Know Yourself

Scouts and guides know how to send messages through Morse code by smoke and by whistles.

In the navy, messages are sent from one ship to another by light signals.

V. Do it Yourself

1. Make a magnet of a solenoid

2. Learn to send messages by Morse code.

VI. Pay a visit to

1. the telegraph office 2. a harbour 3. places using electric bell.

27. HEATING EFFECT OF ELECTRICITY

Feel the regulator of a ceiling fan, after the fan had run for a time. Touch the top plank of a radio after some time. All these are hot. Why are they hot? The current that flows heat them.

Experiment 1

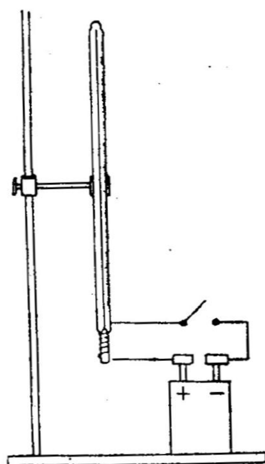


Fig. 100
Heating Effect of Electricity

Aim: (1) To show that a wire is heated when there is a flow of current through it (2) To show that the heat produced depends on the duration of the flow.

Apparatus required: An electric cell, a long thin copper wire, a thermometer, insulated connecting wires, stand, key and a clock.

Procedure: Fix a thermometer on a stand. Note the temperature shown by it. Wind the thin copper wire around the bulb of the thermometer. Connect the free ends of the copper wire to the cell through the key with the connecting wires. Press the key

and there is a flow of current through the wires. Note the reading in the thermometer after some time. There is a rise in the temperature. Disconnect the circuit by switching off the key. Allow some time to pass and note the reading of the thermometer. It falls to the initial temperature. The thermometer had shown the heat produced in the wire around its bulb. This shows that the **electric wire becomes hot when there is a flow of electric current through it.**

Repeat the above experiment and note the initial temperature shown by the thermometer. Pass the current through the wire for 10 minutes by pressing the key. Note the rise in temperature. Disconnect the circuit and allow the system to come to room temperature. Again perform the experiment for 20 minutes and note the rise in temperature. What difference do you observe in the two experiments? The rise in temperature is greater in the second experiment. Hence we see that the **heat produced is greater when the duration of the flow of electricity through the wire is longer.**

Experiment 2

Aim: To show that the heat produced in an electric wire depends on the length of the wire.

Apparatus required: A long thin copper wire, a thermometer, an electric cell, key, connecting wires and stand.

Procedure: Cut two pieces, one 20 cm. long and another 40 cm. long from a thin copper wire.

Wind the smaller wire (20 cm.) round the bulb of the thermometer. Connect the free ends of the wire to the cell, through a key into the connecting wires. Press the key and pass the current through the wire for 10 minutes. Note the rise in temperature from the thermometer. Disconnect the system.

Repeat the experiment with the 40 cm. long wire. Note the rise in temperature. The rise in temperature in the second experiment, with the longer wire, is greater than the first. Hence it is seen that **the heat produced in an electric wire depends upon the length of wire.**

Experiment 3

Aim: To show that the heat produced in an electric wire depends on the thickness of the wire.

Apparatus required: Two copper wires of same length and different thickness, electric cell, key, connecting wires, thermometer and stand.

Procedure: Wind the thicker copper wire over the bulb of the thermometer, connect the free ends of the wire to the cell, through the key, join the connecting wires. Press the key and allow the current to pass through the wire for 10 minutes. Note the rise in temperature from the thermometer.

Disconnect the system. Repeat the experiment with the thin wire. Allow the current to pass through the wire for 10 minutes. Note the rise in temperature from the thermometer. The rise in temperature in the second experiment is greater than in the first. This shows that the heat produced by the flow of

current in the thin wire is greater than in the thicker wire. That is **the heat produced in the electric wire depends on the thickness of the wire.**

Experiment 4

Aim: To show that the heat produced in an electric wire depends on the intensity of the current flowing through it.

Apparatus reeuired: A thin copper wire, two electric cells of equal voltage, key, connecting wires, thermometer and stand.

Procedure: Wind the copper wire round the bulb of the thermometer. Connect the free ends of the wire to one cell, through the key, with the connecting wires. Press the key and allow the current to pass through the wire for 10 minutes. Note the rise in temperature. Disconnect the system.

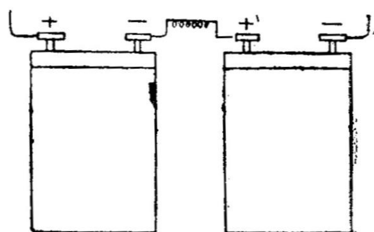


Fig. 101
Series Connection

Connect the two cells in series and make a battery. Now connect the free ends of the copper wire to the two free terminals of the battery. through the key with the connecting wires. Press the key and allow the current to pass through the wire for 10 minutes. Note the rise in temperature. The rise is greater in the second experiment. When cells are connected in series, the intensity of the current flowing

through the wire becomes greater. So, it is seen that **the heat produced in a wire depends on the intensity of the current flowing through it.**

Note: Cells are said to be connected in series, if the +ve of one is connected to the —ve of the other and so on. Finally one + ve terminal and one —ve terminal are free to be connected to the circuit. (Fig. 101).

Experiment 5

Aim: Show that the intensity of the current flowing through being the same, the heat produced in wires of different materials vary.

Apparatus required: Wires of copper, iron, german silver, and nichrome which are of same length and thickness, key, electric cell, thermometer, stand and connecting wires.

Procedure: Wind the copper wire round the bulb of the thermometer. Connect the free ends of the wire to the cell, through the key, by the connecting wires. Press the key and allow the current to flow through the wire for 10 minutes. Note the rise in temperature.

Disconnect the system. Repeat the experiment using the iron, german silver and nichrome wires. The rise in temperature is minimum in copper and maximum in nichrome. The rise in iron is greater than in copper but less than german silver. So, we know that **the heat produced in wires of different**

materials vary, the intensity of the current flowing through them being the same.

To summarise,

1. A wire carrying current becomes hot.
2. The quantity of heat evolved increases with the time for which current is passed.
3. The quantity of heat evolved increases with the length of the wire.
4. The quantity of heat evolved increases with the reduction in the cross sectional area of the wire.

and 5. The quantity of heat evolved increases with the quantity of current.

Electron Theory of how Heat is produced in the Wire

We know that there are free electrons in metals. When there is a current through the metallic wire, there is a flow of these electrons in it. These electrons collide with the atoms of the metal itself and thus heat is produced. There is always a resistance for the flow in the metal which is known as the **electrical resistance.** When the wire is thin, the resistance is high. When the resistance is high, the heat produced is greater.

Nichrome is an alloy of nickel, chromium, steel and manganese. The resistance in nichrome is 70 times as that of copper.

We use nichrome in heaters because

1. it has high resistance.
2. it does not melt even at high temperatures
3. it can be drawn into long thin wires (ductile)

and 4. it does not get rusted.

The thermal effect of electricity is used in appliances like the electric iron, soldering iron and electric kettles.

The Electric Iron

Fig. 102 shows the electric iron. A long thin Nichrome wire is coiled and kept above the bottom

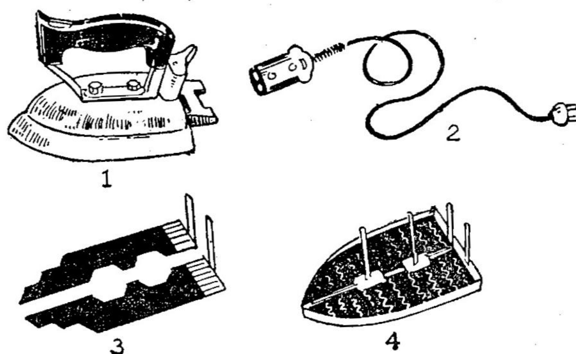


Fig. 102
Electric Iron

1. External Appearance 2. Connecting Wire
3. Upper Part 4. Lower Part (with coils)

plate without touching it. The coil is kept within a frame of porcelain plates, as they are non-conductors. The handle is made of ebonite, another non conductor.

Exercise

I. **Questions**

Answer briefly

1. What are the factors that govern the heat produced in a wire carrying current?
2. Why are nichrome wires used in heaters?

II. **Answer the following in detail**

1. Show by an experiment that the heat produced in wires of different materials are different.
2. Explain the electron theory of the heat produced in an electric wire.
3. Show by an experiment that the heat produced is greater when the wire is longer.

III. **Know Yourself**

Immerse the electric heater in water first and then switch the current on. **Do not put your finger in the water while the heater is on.** Switch off the current and take the heater out. Do not touch the water while the current is flowing.

28. LIGHTING EFFECT OF ELECTRICITY

When a substance is heated, it may glow. For instance, the iron piece in the blackmith's forge is red hot. It may glow white when it is heated further. We know that when electricity is passed through

a wire, it is heated. If it is heated, it becomes red hot or even white hot. It then gives light. This is the lighting effect of electricity

Platinum or tungsten wire is best suited for getting lighting effect. Electric bulbs have tungsten filaments in them, which when heated glow. They become (immediately) white hot when electricity is passed through them. Tungsten filaments are used because platinum wires are very costly and burn off very quickly. In 1879, **Thomas Alva Edison** made the first electric bulb. He used carbon filaments made from bamboo fibres.

Incandescent Carbon Filament Bulb

Fig. 103 shows the primitive carbon filament bulb Bamboo fibre of 3 mm. thickness is burnt and charred. These filaments are held in a glass bulb. The ends of the filament are connected to the copper terminals fixed to the wooden stand. The air in the bulb is drawn out to obtain a vacuum in the bulb It is done to prevent the filament from burning to ashes. In those days, there was no device to create a complete vacuum. So, the filament was short lived. Another defect was that carbon particles (soot) were deposited inside the bulb. It made

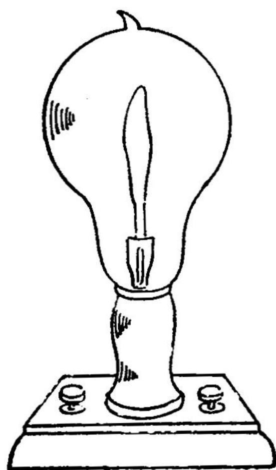


Fig. 103

Bulb with bamboo fibre

the bulb emit only dull light. Edison rectified these defects by using tungsten filaments in vacuum bulbs. He designed the bulb holder also.

Tungsten Filament Vacuum Bulb

The filament here is made of a long tungsten wire. It is kept as a coil inside the bulb. The melting point of tungsten is 3300°C. It becomes white hot very easily. But, it rapidly evaporates and its thickness is reduced. To prevent this, an inert gas like nitrogen or helium is filled inside the bulb instead of having a vacuum. These bulbs last longer and the illumination is better.

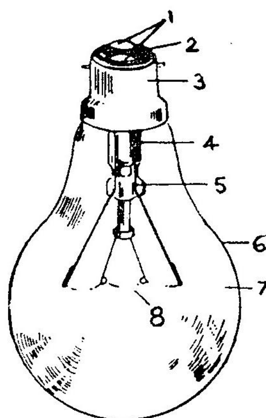


Fig. 104
Filament Bulb

1. Terminals
2. Pitch
3. Metal cap
4. Glass rod
5. Copper wire
6. Bulb
7. Gas
8. Tungsten filament

Fig. 104 shows such a bulb. There is a glass tube inside a glass bulb. Two copper wires are fused to the glass tube separately. The outer ends of the wires are connected to two metallic terminals. These terminals and the top of the bulb are covered by a brass cap. The lower ends of the copper wire are connected to a coiled tungsten filament. The inside of the bulb is filled with an inert gas. The top of the brass cap is filled with pitch. The metallic contacts touch

the pins of the holder. When the switch is on, current flows through the copper wires and the tungsten coil. The coil becomes incandescent immediately and white light is emitted.

Tungsten is used as filament because

1. the melting point of tungsten is about 3300°*C*.
2. its resistance is high.
3. it reaches incandescence readily.
4. it can be drawn into very thin filaments.
5. tungsten filaments do not rust.

Thomas Alva Edison

Edison was born to very poor parents in 1847 in Milan, a city in Ohio. He did not go to school for long. His mother taught him at home. Because of his greater enthusiasm, he set up a laboratory at home. One day he was selling newspapers in the train. That day he saved the son of a railway official from an accident. He was only 10 years old then. That official got him a job in the telegraph office and taught Edison how to make use of the telegraphic machine and send telegraphic messages. He invented very useful devices. He passed away in 1931.

The electric vote recording machine, the carbon microphone, tape recorder are some of his inventions. The telephone, radio and speakers are some more of his inventions. The insulation tapes, switches, bulbs and holders were also invented by him. The extr-

action of some metals from their ores were done by him.

Portland cement, the projector and the cine camera, the electric train, the storage battery in the electric train designed by him are very useful to us. The wireless system by electric induction was devised by him.

Exercise

I. Questions

1. Describe an electric bulb.
2. Why are tungsten filaments used in bulbs?
3. Mention some of the inventions of Edison.

II. Do it Yourself

1. Carefully see an electric bulb and label its parts.
2. Prepare an album on Thomas Alva Edison and his inventions.

29. CHEMICAL EFFECT OF ELECTRICITY

We have seen cycle parts coated with nickel or chromium. The coating is given by a process called **electroplating.**

The heating and lighting effects of electricity are caused in solids (metals). The effect of electricity in liquids is dealt with in this chapter

Take some pure water in a beaker (Fig. 105). Add one or two drops of dilute sulphuric acid to it. Put two copper plates in it, without touching each other. Connect the outer ends of the plates by a connecting wire to a battery. What happens inside the liquid? You see bubbles gathering at the copper plates. On examination the gas collected at the anode (+ve) is found to be oxygen and the gas at the cathode (—ve) is hydrogen. That means water is split up into its components.

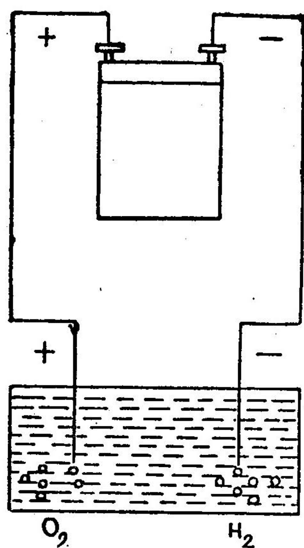


Fig. 105
Electrolysis of Water

Experiment

Aim: To show that copper can be deposited at the cathode by the electrolysis of copper sulphate solution.

Apparatus required: A clean dry glass trough, water, copper sulphate crystals, glass rod, battery, two carbon rods, connecting wires, key.

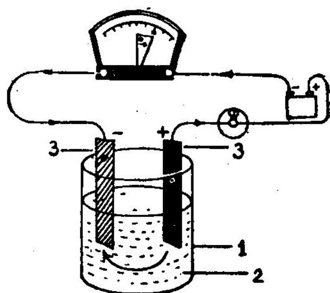


Fig. 106
Electrolysis of Copper Sulphate Solution

1. Glass trough
2. Copper sulphate solution
3. Carbon rods

Procedure: Make a solution of copper sulphate. It is greenish blue. Pour it in the glass trough. Place the two carbon rods without touching each other in the liquid. Connect the rods to the battery, through a key, with the connecting wires. Press the key and there is a flow of electricity through the rods. After some time, the blue colour of the copper sulphate solution disappears and the liquid becomes colourless. Stop the flow. Take the carbon rods out and examine them. We find a fine deposit of copper on the carbon rod that is connected to the —ve of the battery.

The rod connected to the +ve is the **anode.** The rod connected to the —ve is the **cathode.** The liquid is known as the **electrolyte.** The process is called **electrolysis.**

Note

1. Solutions of metallic salts are electrolytes, for they allow electricity to pass through them.

2. When metallic salts are subjected to electrolysis, a fine deposit of the metal is got on the cathode.

Electroplating

We are aware of the fine deposit of the metal at the cathode during electrolysis. This process is called electroplating.

Experiment

Aim: To electroplate a copper spoon with silver.

Apparatus required: A glass vessel, the copper spoon, pure silver plate, a solution of the double

cyanide of silver and potassium, battery, key and connecting wires.

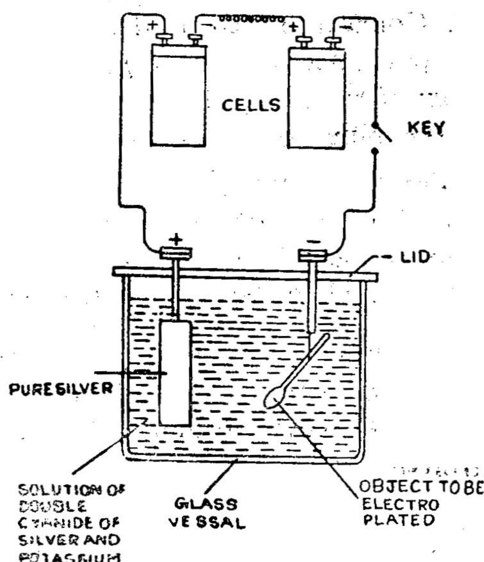


Fig. 107

Electroplating

Procedure: The spoon should not be greasy. Boil it for sometime in sodium hydroxide solution. Clean it with water and dry it.

Take the solution of the double cyanide of silver and potassium in a glass vessel. Suspend the pure silver plate and the copper spoon in the solution away from each other and without touching each other. Connect the copper spoon to the cathode and the silver plate to the anode. Connect the system to a battery, through the key, with the connecting

wires. Press the key and make the current flow through the system. Pass an uniform flow of current for sometime. Stop the current and take the spoon out. Wash with water. We see a fine coating of silver on the copper spoon.

Points to be noted during electroplating

1. The article to be electroplated should not be greasy.

2. The article which is to be electroplated, should be connected to the cathode.

3. The pure metallic plate or bar is to be connected to the anode.

4. The solution of the metallic salt becomes the electroyte.

5. The flow of electricity should be uniform. The intensity of the current should be less and should be passed for a longer duration.

6. The set up should not be shaked during the process.

7. The article should be taken out after the electroplating, washed and polished.

Memorise the following:

Metallic coating	Electrolyte	Anode	Cathode
Gold	Solution of double cyanide of gold and potassium	Pure gold plate	Article to be elec-troplated
Silver	Solution of double cyanide of silver and potassium	Pure silver plate	Article to be elec-troplated
Copper	Copper sulph-ate solution	Pure cop-per plate	Article to be elec-troplated
Nickel	Solution of ni-ckel ammonium sulphate	Pure nic-kel plate	Article to be elec-troplated

Michael Faraday (1791 - 1867)

Faraday was born of poor parents in Newlington, near London. He did not have much of a schooling. He was an apprentice with a book binder. He evinced great interest in reading science books and made a note of everything he read.

Once he sent a bound volume of his notes to Sir **Humphrey Davy**, the noted physicist and President of the Royal Society of England. The volume contained the notes of the lectures of Davy (taken by Faraday). Davy saw to it that Faraday was taken

into the Royal Society. Faraday accompanied Davy in his lecture - tour of the continent. It was the great fortune in his life and helped him in his research. Faraday, by his tireless work and research, became the President of the Royal Society. Though awarded the highest honour of his day, Faraday led a very simple life. He invented the dynamo. His research on static electricity, magnetism etc. was useful for other scientists and future research. His laws on electrolysis are very useful.

Faraday's Laws of Electrolysis

1. When solutions of metallic compounds are electrolysed, the metals are deposited on the cathode.
2. The quantity of the metal deposited increases with the intensity of the current and the time of flow.

Exercise

I. Pay a visit

Visit and see an electroplating outfit.

II. Do it Yourself

Collect and prepare an album about Faraday, his life and inventions.

VII. ASTRONOMY-ASTRO PHYSICS

30. THE SOLAR FAMILY

We look at a million stars in the sky at night. Some of them twinkle and others throw constant light. The stars are far away from the earth. Some of the celestial bodies are planets. The arrangement of stars as a whole is known as the **Galaxy** and one such galaxy to which the earth belongs is known as the **Milky Way**.

The **Sun**, responsible for day-light is one of the stars stated above. Because of its bright light.

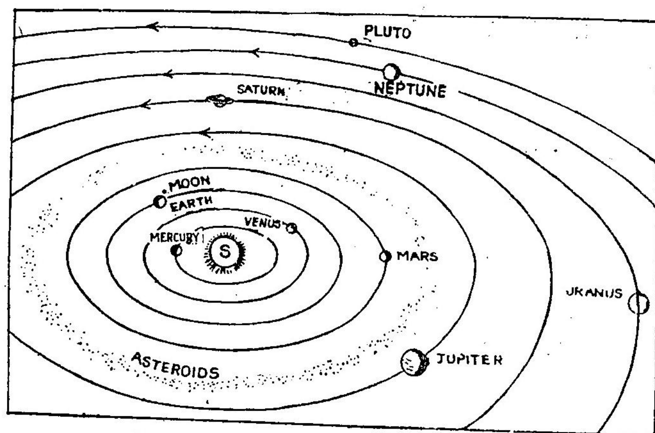


Fig. 108
Solar Family

other stars are not visible during the day time. The sun and nine planets namely **Mercury,**

Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and **Pluto** constitute the solar family. They move along an orbit of their own. Besides the planets, there are **asteroids** and the **comets**. Some of the planets have moons going round them in orbits. Jupiter has twelve moons, Earth has one, Mars has two, Saturn has nine, Uranus has five and Neptune has two amounting to thirty one moons. There are many **Galaxies** like this in the Universe.

The Sun: It is a ball of fire. It is at a distance of 15 billion km. from the earth. It is 13 lakh times bigger than the earth. Photosynthesis, rain and vaporization of water - all these happen because of the light and heat of the sun. Sunlight is necessary for our living.

It is not a solid as the earth. It is of concentric layers of burning gases. The centre is known as **photosphere.** Around the photosphere is the **chromosphere** and the outer layer is the **corona.** Only a small quantity of the heat from the sun reaches us. We are not able to bear even that quantity.

Planets

1. Mercury

This is the smallest of the planets and is nearest to the sun. It takes 88 days for this planet to go round the sun once. It does not spin and hence one half is always facing the sun and the other half is always dark. The bright face is extremely hot and the other face is severely cold. There is no atmosphere here and so life is not possible.

2. Venus

It is also known as the morning star. It is solid and is similar to earth in volume, weight and gravitational force. But living is not possible here. It rotates itself and goes round the sun once in 225 days.

3. Earth

We know a lot about the earth and the moon that is a satellite of the earth.

4. Mars

This is a reddish planet to us. It is said that a heavy layer of dust is around this. Scientists think that living in Mars is possible. They are exploring the possibilities of growing living organisms in Mars.

5. Jupiter.

Next to the sun, the Jupiter is the biggest in the solar family. It is 1300 times bigger than earth. It takes ten hours to revolve itself once and takes twelve years to go once round the sun. This planet is covered by snow. It was **Galileo** who discovered this planet. Out of its twelve moons, eight go clockwise and four go anticlockwise.

6. Saturn

This planet is next to Jupiter in size. There are three multicoloured rings around this. It is 600 times bigger than earth. It takes twenty eight years to go round the sun. Like Jupiter, the surface of Saturn also is covered by snow.

7. Uranus

This takes 84 years to go once round the sun.

8. Neptune

This planet takes 165 years to go once round the sun.

9. Pluto

This planet is in the outer most orbit. It is far away from the sun than other planets. It takes 248 years to go round the sun once.

The last three planets get the least light and heat from the sun.

Energy from the Sun

We know that the sun has abundant hydrogen and helium at very high temperature. Hydrogen atoms fuse to form helium atoms at this temperature. By this change more light is emitted. Innumerable electrons are there and various forms of electromagnetic radiations are caused by the sun. The sun thus becomes a big atomic reactor. It is estimated that nearly 300 crore units of electrical energy are evolved every second from the sun. We use only a very small quantity of this energy.

We now have devised many appliances that work by solar energy. Solar ovens, solar batteries and other appliances are used nowadays. Scientists have succeeded in running a car by solar energy. There are solar panels in the **'Apple'**. They are costly. But scientists are doing research in developing simple and cheaper appliances.

Sunspots

People thought of the sun as a spotless globe of fire till 1610, before Galileo proved the existence of sun spots. He proved by his telescopic observations that these spots move and that the sun rotates itself. These spots appear in the same position once in every 27 days. Thus it was proved that the sun takes 27 days to rotate itself once.

Meteors and Comets

Some of the particles around the sun are thrown out. They fall towards the earth because of gravity.

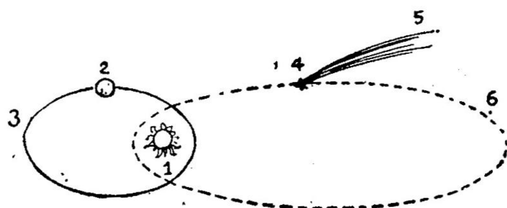


Fig. 109

Comet

1. Sun 2. Earth 3. Orbit of the Earth
4. Head of the Comet 5. Tail of the Comet
6. Orbit of the Comet

They burn because of the friction with the atmosphere. Normally they are completely burnt before they reach the earth. But those which fall on the earth are known as meteorites. They are found to contain iron and carbon.

Comets go round the sun in their own orbits. The tail is away from the sun: It is believed that

the comet contains gas and dust particles. Halley's comet was last seen in 1910 and is likely to reappear in 1985.

Cosmic Rays

These are the most powerful of all the radiations from the sun. *X*-rays cannot pass through a thin plate of lead. But cosmic rays can penetrate through a lead plate several centimetres thick. The intensity of these rays decrease as they reach the earth. The source and properties of these rays are not fully known yet. These rays collide with the atoms of all the gases present in the atmosphere. Because of this collision, most of this energy does not reach the earth. This ray may cause cancer, tuberculosis and asthma.

Voyage to the Moon

Close the mouth of an inflated balloon with your finger. Release the finger. Immediately the balloon is shot in the opposite direction, as the air in the balloon gushes out from the mouth. Likewise, in a rocket, gases at a very high pressure are burnt and forced downward and the rocket speeds upwards. When the fuel is exhausted, the rocket comes down by its own weight. To minimise the space for fuel, hydrogen and oxygen are in the liquid state.

If the rocket is pushed up beyond the field of gravitation of the earth, it cannot come down. Now they operate the engines and brakes to take the rocket into the gravitational field of the moon. It is possible to land on the moon by acting against its gravity by slowly applying the brakes.

The satellites are also launched in this method. They are taken to the orbit by rockets and are left there. They go round in their orbit and 'obey' the 'commands' from ground control. The first men to land on the moon were **Armstrong** and **Aldrin**, two American astronauts. The day is not far off, when you and I can go to the other planets, like we go from one place to another on the earth.

Exercise

I. Answer briefly

1. What are the planets in the solar system?
2. One face of Mercury is very hot and the other is very cold. Why?
3. How do the moons around Jupiter behave?
4. What are meteorites?
5. How can solar energy be used?
6. Write short notes on - cosmic rays, comets, photosphere, corona.

II. Complete the sentences

1. The reddish planet is ————
2. There are ——— round the saturn.
3. ——— discovered the sun spots.

31. X-RAYS, RADIOACTIVITY, RADIUM

One day, when the Second World War was at its peak, American bombers flew over Hiroshima and Nagasaki and bombed them. They were towns

in Japan and the bombs were atom bombs. The war came to an abrupt end. The after effect of the bombs have not yet subsided. The children born are defective freaks. People could not live there. It is because of the radioactivity due to atomic explosion. The tremendous energy that destroyed the living beings is now harnessed for the betterment of society.

We have atomic reactors at **Tarapore** in Maharashtra, **Kota** in Rajasthan and **Kalpakkam** in Tamil Nadu. They supply nuclear power for many projects.

Henry Becquerel, a French scientist, was the first to do certain experiments with the elements like uranium and radium which glow in darkness. The rays emitted from these materials are like the *X*-rays of **Roentgen.** The rays are different from *X*-rays in some aspects. The energy we get by the atomic fission is very great. The process of the emission of these rays is known as **radio activity.**

X rays, we know, are used to detect the fractures in our bones, the defects of our internal organs like the stomach etc. It was first discovered by Roentgen, a German scientist.

He was observing the properties of the cathode rays, using Crookes' Tubes. The Crookes tube is a glass tube as in Fig 110. There are two metal plates at both the ends of the tube. One is the anode and the other is the cathode, when connected to a battery. The air in the tube was removed and he

saw multicoloured glows in the tube. (at various pressures). As these glows seem to emerge from the cathode, they are called **cathode rays.**

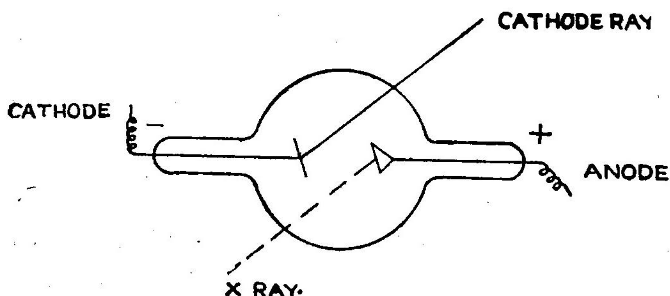


Fig. 110
Crookes Tube

Roentgon had closed the tube by a box of black paper. When he passed the current through the tube in complete darkness, some glass plates coated with barium salts on them began to glow. When the current through the tube was stopped, the glow also ceased. He thought of this as a mystery and called them '*X*-rays'.

These rays penetrate practically all objects. Accidentally his palm was on the path of these rays. He found that he was able to see the bones of his palm registered on the photographic plate kept in line. This property of the *X* rays is now made use of in medical sciences. Even in factories, these rays are used to detect the defective parts of a machinery. It can measure the thickness of a thin glass plate, or a thin wire. It can expose the fine cracks on porcelain or glassware. The tenacity of a steel spring

can be found by using *X* rays. It can even differentiate between original currency and a counterfeit currency note, a pseudoportrait, a defective gem, the fake spare parts of a mechine from the original.

Marie Curie - Pierre Curie

There cannot be a student of science, who does not know the name of Marie Curie. She was twice awarded the Nobel Prize. Pierre was her scientist husband. She survived him and continued his research projects.

They found that uranium salts emit rays and these rays were very powerful. They also found that these rays were rich in **pitch blende**, an ore of uranium. They also discovered **polonium** in 1898 and **radium** in 1902. Polonium is 100 times more effective than uranium and radium is more effective than polonium.

The intensity of these radiations is very high. They can ionise the surrounding air. Though they can kil germs, they develop a wound where our body is exposed to them. So people affected by cancer are being treated by radium therapy.

Part II. CHEMISTRY

1. MATTER AND THEIR STATES

In our every day life, we come across various kinds of substances. Some of them are solids, some are liquids and some are gases. The chair that we sit upon, the pen that we write with, the house that we live in, the food stuffs that we eat are all examples of matter. These matters are in solid state. Solids have definite shape, volume and weight.

Water, oil, milk, and mercury are examples of matter in the liquid state. Liquids do not have a definite shape. They take the shape of the vessel in which they are placed. When a liquid is transferred from one vessel to another, it takes the shape of the vessel to which it is transferred. However, its volume or weight does not change.

The air that surrounds us, the oxygen that we inhale, the carbon-di-oxide that escapes when a bottle of an aerated drink is opened and steam are examples of matter in the gaseous state.

Gases do not have a definite shape or volume but have weight.

From the above examples, we understand that matter encloses space and that it has weight.

Matter may be defined as that which encloses space, has weight and resistance.

The following simple experiment will show that air has weight.

Take two balloons of equal weight and fill them with air using an ordinary cycle inflator. Tie the balloons to the two ends of a metre scale. Suspend the metre scale with the balloons horizontally with the help of a string from a stand. Prick one of the balloons with a pin and expel the air from it. Now you will observe the end of the metre scale with the punctured balloon going up a little and the scale no longer remains in the horizontal position. Why does this happen?

This is because the air in it has escaped. Hence the weight of the other balloon is greater than this punctured balloon. From this we learn that air has weight.

In the same manner, if we repeat the same experiment with different gases, we will observe that gases have weight.

If you release two balloons, one filled with air and the other with hydrogen, which of these balloons will go up? Why?

States of Matter

You have learnt that matter exists in three states namely solid, liquid and gaseous. Solids do not change their size and shape. For example, a piece of iron does not undergo any change in its shape or

volume on its own. However, solids expand a little due to heat.

Liquids change their shape but their volume does not change. Liquids take the shape of the container which holds them.

This can be demonstrated by a simple experiment which you can perform easily at home. Take three or four glass bottles of various shapes. Pour into

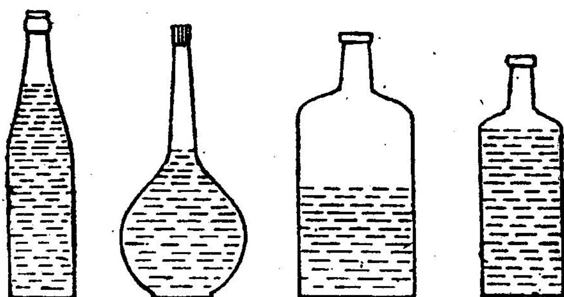


Fig. 111

Water takes the shape of the container

each bottle an equal quantity of water, say 100 ml. Now observe that the same quantity of water stands at different levels in different bottles. This shows that liquids do not have a shape of their own, but assume the shape of the container.

Like solids, liquids too expand due to heat.

Gases do not have a definite size or volume. Take five or six rubber balloons of various shapes and sizes and fill all of them with air with the help of an inflator. You will observe that air fills the

balloons and inflates them. The air gets the shape of the balloon. Therefore air can fill in any space

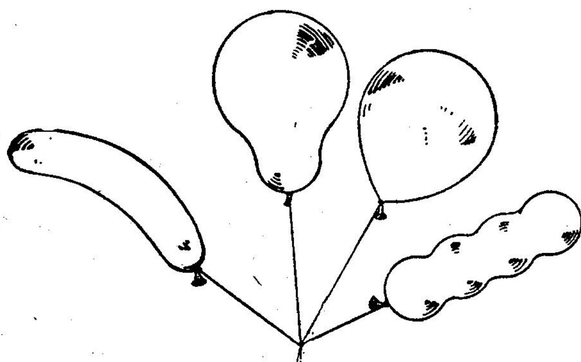


Fig. 112

Gases do not have definite volume or shape

or container and assume its shape. This shows that gases also do not have a definite shape.

Inflate a foot ball bladder with a little air. Press it with your hand. You will feel that it is soft. Pump more air into the bladder. Now you will feel that it is harder. You can pump more and more air into the bladder and make it very hard. This shows that gases do not have a definite volume. It is possible to pump more and more air into the limited space of a foot-ball bladder.

Similarly you know that we use a rubber air pillow by blowing air into it. The moment we blow air into it, the quantity of air increases, but the volume of the air-pillow does not change. From these two examples, it is clear that air has no definite volume.

The following tabular column gives a comparative study of the properties of solids, liquids and gases:

State	Shape	Volume	Example
Solid	does not change	does not change	brick, book and pen
Liquid	changes	does not change	water, milk and kerosene
Gas	changes	changes	air and water-vapour

Change of State

When matter changes from one state into another, it is called **'change of state'**

Water presents itself as a very good example for this change of state. When water is cooled, it freezes and changes into ice. When water is heated, it evaporates and turns into steam. You might have observed how solid iron is melted and turned into molten iron and how this molten iron when poured into casts, solidifies and again becomes solid iron. In every day life, you might have observed the melting of wax. On being heated, it changes into liquid and becomes solid again when cooled. All these examples show that matter changes from one state into another state.

Water from the oceans, lakes, tanks, ponds etc. evaporates due to the sun's heat and the water vapour

goes into the atmosphere. The water vapour then condenses into tiny particles of water.

This is an example of change of state.

From the above example, you will understand that heat energy changes the state of a matter from

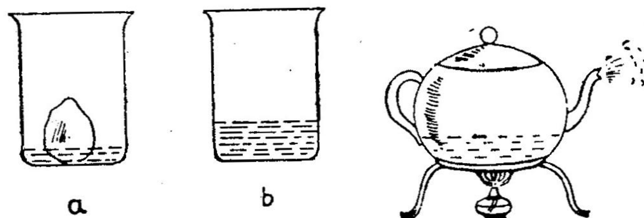
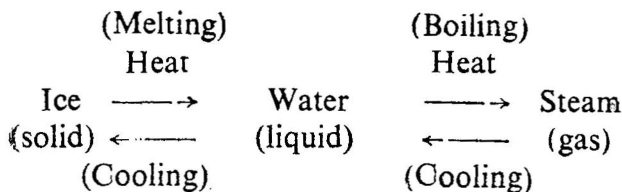


Fig. 113
Changes in state of water
(*a*) Ice (*b*) Water (*c*) Steam

one state to another. We call this as **"change of state"** of matter.

Change of State of Water

Ice melts due to heat and turns into water. Water, when heated, becomes steam. Steam, on cooling, changes into water. When water is further cooled, it becomes ice. These changes can be represented as follows:



Melting Point

Change of state in a substance takes place only at a definite temperature. For example, ice melts into water only at the definite temperature of 0°*C*. This temperature is known as the melting point. Different solids have different melting points.

The table below gives the melting points of a few substances:

No.	Substance	Melting Point
1.	Ice	0°*C*
2.	Wax	54°*C*
3.	Sulphur	112·8°*C*
4.	Gold	1063°*C*
5.	Iron	1535°*C*
6.	Platinum	1769°*C*

Boiling Point

When water is heated, its temperature rises gradually and at a particular temperature, water boils vigorously and large quantities of steam rise from the surface of the boiling water. Boiling of water takes place at a definite constant temperature (*i.e.*) 100°*C*. This temperature is called the boiling point of water.

The following table gives the boiling points of a few liquids.

No.	Liquids	Boiling Point
1.	Bromine	58·8°C
2.	Ethyl Alcohol	78·3°C
3.	Benzene	80·2°C
4.	Pure Water	100°C
5.	Mercury	356·6°C

Freezing Point

Water kept in a freezing mixture solidifies and turns into ice. This happens at the constant temperature of 0°C. This constant temperature is known as the freezing point of water.

The following table gives the freezing pionts of a few liquids:

No.	Liquids	Freezing Point
1.	Water	0°C
2.	Ethyl Alcohol	—114·4°C
3.	Mercury	—38·87°C

Sublimation

Solid ice melts and turns into water and when heated further turns into steam. But some substances do not exist in all the states (*i.e.*) the solid, liquid and gaseous states. Some solids, on being heated, directly pass into the gaseous state without melting and becoming a liquid. The vapour on cooling directly turns into solid. This is called sublimation.

You might have observed a piece of camphor burning. If not, take a piece of camphor and light it. Observe carefully. You will notice how camphor burns and passes into vapour without melting.

Take a few crystals of iodine in a china dish and invert a funnel over the iodine crystals as shown in the figure. Now heat the iodine (china dish) with the help of a spirit lamp. You will observe violet vapours rising from the iodine crystals and going up. The iodine crystals do not melt. The violet vapours, on coming into contact with the cooler parts of the funnel, condense and settle there.

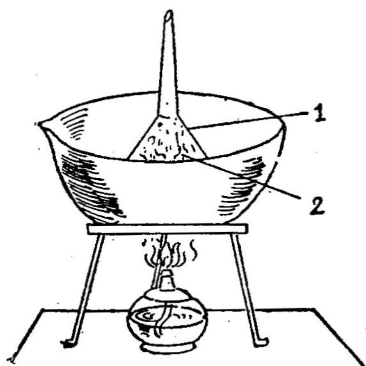


Fig. 114
Sublimation of Iodine
1. Iodine Crystals
2. Iodine Vapour .

Thus some solids on being heated directly pass into the vapour stage and the vapours on being

cooled, directly turn into solid. This phenomenon is called sublimation. Camphor, ammonium chloride, naphthalene are substances which exhibit the property of sublimation.

Exercise

I. Questions

1. Indicate the state in which the following substances exist:

   (i) Book (ii) Milk
   (iii) Top (iv) Cloud
   (v) Smoke

2. Why is it possible to pump more and more air into a football bladder?

3. What are the differences between solids and liquids?

4. What is meant by change of state? Explain with an example.

5. Define the melting point of a substance?

6. What is the melting point of ice?

7. What is meant by the boiling point of a substance?

8. Will the boiling points of all the substances be the same? Explain with reasons.

9. What is meant by sublimation? Explain with an example.

II. Do it Yourself

1. Burn a little of camphor and observe what happens.
2. Pour a little petrol in a small dish and observe what happens.
3. Take a little quantity of powdered wax in a spoon and heat it. Then cool it. Observe the changes that take place.

III. Pay a Visit

1. to an ice factory and observe how ice is manufactured.
2. to the tin smith's shop and find out how tin coating is done. Note down the names of the substances used.

IV. For Thought

1. Why do tiny droplets of water appear on the outside of the vessel in which ice is kept?
2. Why do tiny droplets of water appear on the blades of grass early in the morning during winter?

2. ELEMENTS

In our homes we use many kinds of materials. For instance, we use vessels made of iron, copper and brass. We wear ornaments made of gold and silver. We use water, milk and kerosene. We also use materials

like bricks, sand and cement to build houses. We inhale oxygen. In some houses liquified gas is used as fuel for cooking. All these substances are different in shape, structure and properties. These substances may be divided into three broad categories. They are (1) **Elements** (2) **Compounds** and (3) **Mixtures.**

Iron and copper are elements. Milk, water and kerosene are compounds, air and brass are mixtures.

Elements

Take a small piece of iron. Split it into smaller and smaller bits. You will reach a stage when it is no longer possible to split it further. Whatever physical or chemical process is used for splitting, the final product will be iron. Iron cannot be broken down into any thing other than iron.

Take some water in a voltameter and add a little acid to it. Pass electricity through this water. You will observe that water is split up into two gases namely oxygen and hydrogen. In this process water (liquid) is split up into two gases oxygen and hydrogen which are different from water in all respects.

Hydrogen and oxygen cannot be split up into simpler substances of a different nature. These substances are called elements. Similarly electrolyse a solution of common salt. You will observe that the solution breaks up into a solid called **sodium** and a gas called **chlorine.** Sodium cannot

be further split up into any material other than sodium. So is the case with chlorine.

From the above examples seen so far, it is clear that it is not possible to split up iron, oxygen, hydrogen or chlorine into new and simpler substances by any chemical process.

Substances which cannot be split up by any chemical methods into further different and simpler substances are called elements.

Discovery of Elements

How is it possible to identify an element? For instance, you are given a substance like alumina. Is it an element or a compound? You have only to try to break it up into simpler substances by some process. An ordinary process like heating does not yield results. A chemical process like electrolysis may be tried. When alumina is electrolysed, it is spilit up into aluminium, a solid and oxygen, a gas each of which is an element.

From the olden days, philosophers and after them chemists were keenly interested in identifying new elements. The great Greek philosopher **Aristotle** (384-322 B.C.) considered that all matters were composed of earth, air, fire, and water. These are known as **'Artistotelian elements'**.

A section of the chemists were known as alchemists. The alchemists spent most of their time in attempting to convert baser metals into gold. They thought that sulphur, mercury and salt were the only

three elements found in the world. However, it was only **Robert Boyle** (1627-1691) the great scientist who defined an element. His definition has been accepted by scientists of today.

At the beginning of the 19th century, scientists knew only about 30 elements. At the beginning of this century, 83 elements had been discovered. But now 105 elements have been identified and discovered.

All substances are made up of one element or a combination of two or more elements. The elements are the **'building bricks'** of all substances. All living organisms are made up of a number of elements. Some of the important elements that are found in large quantities in the human body are oxygen, carbon, nitrogen, calcium and phosphorus. Of these elements, oxygen alone accounts for 65% of the elements found in the human body.

Elements in Nature

We have already seen that matter exists in a solid, liquid and gaseous states. Some elements are found in free state. Elements are also found in combined states as compounds.

These elements or compounds are found in the atmosphere and in the earth's crust.

These elements are found in varying quantities. Some are found in large quantities and some in very small quantities.

Some of the elements found in free state are gold, silver, copper and sulphur.

Some are combined with oxygen and sulphur and are found as oxides and sulphides respectively. Iron and silicon combine with oxygen and give us iron oxides and silicon-di-oxide (sand).

Copper in combination with oxygen and sulphur is available as copper oxide and copper sulphide respectively. Oxygen and hydrogen combine to form water. Water is found in very large quantities on the earth's crust.

Most of the elements are found on the earth's crust. Nine among them are available in considerable quantities. The following table shows their distribution by weight on the earth's crust. These elements constitute 98% by weight of the earth's crust. The remaining elements form only 2%.

No.	Element	Weight %
1.	Oxygen	50
2.	Silicon	26
3.	Aluminium	7
4.	Iron	4
5.	Calcium	3
6.	Sodium	2·5

No.	Element	Weight %
7.	Potassium	2·5
8.	Magnesium	2
9.	Hydrogen	1
10.	Other 83 elements	2

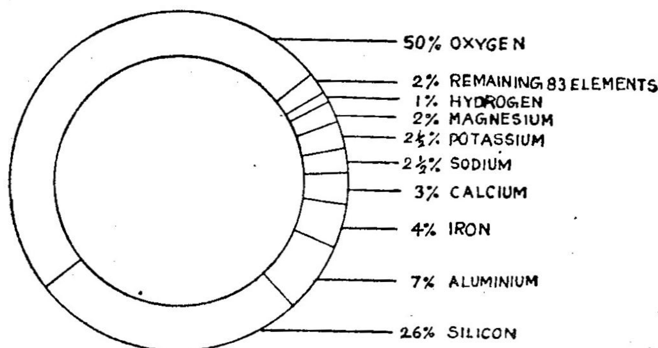


Fig. 115

Proportion of notable elements on the earth's crust

Synthetic Elements

Seventeen of the 105 elements known so far are not found in nature but are prepared in the laboratories by a special process. These elements are known as synthetic elements. Examples for synthetic elements are (1) Einsteinium (2) Fermium (3) Mendilvium (4) Nobelium (5) Lawrencium (6) Rutherfordium and (7) Hahnium.

Kinds of Elements

Elements have been broadly classified into two groups, namely, **metals** and **non-metals.** Some of the important metals and non-metals are shown hereunder:

Metals	Non-metals
Aluminium	Chlorine (gas)
Calcium	Oxygen (gas)
Manganese	Nitrogen (gas)
Zinc	Hydrogen (gas)
Tin	Bromine (liquid)
Copper	Sulphur (solid)
Iron	Phosphorus (solid)
Silver	Carbon (solid)
Gold	Iodine (solid)
Mercury (liquid)	Silicon (solid)

When you look at the table given above, you are likely to doubt why aluminium should be classified as a metal and chlorine as a non-metal. Elements which are classified as metals possess certain properties which are different from the properties of non-metals.

The following table will illustrate the common properties of metals and non-metals:

No.	Metals	Non-Metals
1.	Possess metallic lustre	Do not possess any lustre
2.	Under ordinary temperature exist as solids (except Mercury)	Under ordinary temperature exists as solids, liquids and gases.
3.	High boiling point and melting point	Low boiling point and melting point
4,	Hard in nature	Comparatively soft
5.	Good conductors of heat	Non-conductors of heat
6.	Good conductors of electricity	Non-conductors of electricity
7.	Malleable and ductile	Non-malleable and not ductile

Some elements exhibit qualities common to both metals and non-metals. They cannot be called either metals or non-metals. They are called **metalloids.**

Arsenic and antimony are examples for metalloids.

Most of the elements are metals (80). Twenty of the remaining are non-metals. A few are metalloids.

Many chemists attempted to classify and catalogue the various elements based on different principles. However, it was **Mendeleef**, the great Russian chemist who gave the world a most satisfactory and acceptable method for the classification of elements. You will study in detail about Mendeleef's periodic law and Mendeleef's periodic table in higher classes.

Elements and their Symbols

Instead of writing the full name of elements and compounds, it would be easier and more convenient to use symbols which could be understood and followed by all. Such a symbolic representation would save time.

Thus, for some elements the first letters of their names are used as symbols to represent the elements. For example, *H* stands for hydrogen, *N* for nitrogen, *S* for sulphur, *C* for carbon, *P* for phosphorus, *I* for iodine and *O* for oxygen.

The names of some elements begin with the same alphabet For example, *C* is the first letter for carbon, calcium, chromium, chlorine, and cobalt. So these elements are represented by two letters. Thus *Ca* stands for calcium, *Cr* for Chromium, *Cl* for Chlorine and *Co* for Cobalt. Here besides the first letter another prominent letter in the name of the element is used. A few more examples of this kind are *Mg* for Magnesium, *Mn* for Manganese, *Al* for Aluminium, and *Ba* for Barium.

The symbol used for a few other elements are based on their Latin names. For example, aurum

is the Latin name for gold. So *Au* stands for gold. A few more examples of this kind are given hereunder:

Symbol	Latin Name	English Name
Ag	Argentum	Silver
Cu	Cuprum	Copper
Fe	Ferrum	Iron
Na	Natrium	Sodium

At the beginning of the 17th century, only a few elements were known to the chemists. Those elements were given names with astronomical connections like the sun, the moon etc., For example, iron was represented by Mars. Mars was the name of the mythological Greek god of war. Iron was largely used for making weapons of war. Gold was named after the sun and silver after the moon. These were represented by suitable symbols. Can you guess why these elements were named after the sun and the moon? The following table gives the modern names of some of the elements, their ancient names with symbols. Some of the names have remained unchanged.

Name of The Element	Ancient Name	Symbol
Gold	Sol (sun)	☉
Iron	Mars	♂
Silver	Luna (Moon)	☾
Sulphur	....	🜍
Copper	....	♀
Mercury	....	☿

The French chemist **Lavoisier** and a few of his contemporary ehemists suggested that from their time onwards all newly discovered metals should be given names ending is "*um*" and all non metals names ending in "*on*".

The modern names of elements are derived from several sources. Some elements take their names after some of the planets in the solar system. Uranium, Neptunium and Plutonium are examples for this kind of nomenclature. The names of some other elements are derived from the ancient European mythology. For example, mercury is named after the Roman mythological messenger of God. Mercury was depicted with wings on his heels and running extremely fast carrying the messages. Can you guess why the element has been named so?

Some elements have been named on the basis of their chief properties like appearance, colour

and smell. Iodine derives its name from the Greek word meaning 'violet'. Bromine derives its name from the Greek word which conveys the meaning of 'bad odour'.

Most of the elements discovered during the course of this century have been named after the place of discovery or the chemist who discovered them. Einsteinium, Curium, Californium, Francium, Americium and Europium are examples of this kind of naming.

You are young today. You may also discover new elements when you grow up and bring credit to yourself and to your motherland.

Exercise

I. Question

1. How is matter classified? What are they?
2. What is an element?
3. Give some examples for elements.
4. Name three elements which are found in large quantities on the earth's crust?
5. How is silicon found on the earth's crust?
6. How are elements classified?
7. Give the names of three elements which are found in combined state on the earth's crust. How are they combined?
8. Represent diagramatically, on the basis of their proportional weights, elements found on the earth's crust.

9. **What are synthetic elements? How are they synthesised?**

10. How many elements have been synthetically produced? What are they?

11. Tabulate the differences between metals and non-metals.

12. What are metalloids? Why are they called so?

13. What are the symbols of the following elements?

    (1) Magnesium (2) Mercury (3) Silver (4) Bromine (5) Nitrogen (6) Copper

14. What do the following symbols stand for:-

    (I) *B* (II) *Fe* (III) *I* (IV) *O* (V) *Si* (VI) *Na* (VII) *K* (VIII) *Mn* (IX) *Mg* (X) *Hg*.

15. State whether the following are metals or non-metals. In what way are they different from the class to which they belong?

    (1) Copper (2) Diamond (3) Graphite (4) Iron.

II. Do it yourself

1. With the help of a 6 volt battery pass a current through a piece of paper wire, a piece of charcoal, an iron wire, a piece of sulphur respectively and test whether a small bulb included in the series glows or not.

2. Examine the physical properties of iron, copper, zinc, lead, tin, aluminium, mercury, sulphur, phosphorus, sodium, potassium.

III Pay a visit to

1. Any place near your village or town where any metal or a non-metal is extracted.
2. Any workshop where aluminium or copper utensils are manufactured.

IV. Learn Yourself

1. Examine Mendeleef's periodic table exhibited in your school chemistry laboratory and try to learn about the various elements and their symbols.
2. About the metallic resources of our country with special reference to Tamilnadu.

V. For Thought

1. The inside of an electric switch is covered with cobweb. You should not clean it up with the lead of a pencil. Why?
2. Write down in the tabular column given hereunder the names of the places in your neighbourhood where important industries are set up. Specify the name of the industry also.

Serial No.	Name of the place	Name of the important industry
1.		
2.		
3.		
4.		
5.		
6.		
7.		

3. COMPOUNDS

When iron and sulphur are heated together a new substance called iron sulphide is obtained. This new substance is completely different from iron or sulphur. Iron sulphide is an example for a compound.

Take a piece of charcoal and heat it over a flame. The charcoal at first glows, then catches fire and burns brightly. A gas is evolved. Collect this gas in a test tube and add clear lime water to it. The lime water turns milky. You know that carbon-di-oxide alone has the property of turning lime water milky. Carbon-di-oxide is produced when carbon

burns in oxygen. Hence carbon-di-oxide is a compound.

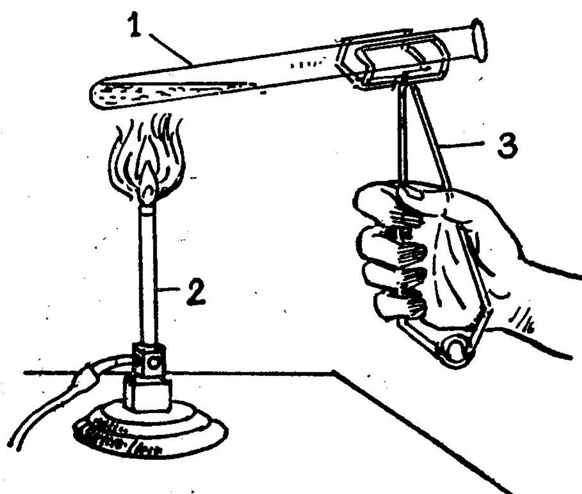


Fig. 116
Preparation of a Compound

1. Test tube 2. Bunsen Burner 3. Test Tube Holder

Heat a strip of magnesium. The strip takes some time to catch fire. It burns with a dazzling brilliance. The metal is now reduced to white ash and this is nothing but magnesium oxide. Magnesium oxide is another example for a compound. When magnesium burns in air, it combines with oxygen to form magnesium oxide which is completely different in its properties from that of magnesium or oxygen.

Sodium is a whitish bright element in the solid state. Chlorine is a gaseous element greenish yellow in colour. Heat a little sodium in a deflagrating spoon

in a jar containing chlorine gas. A new substance called sodium chloride (common salt) is now formed. This is another example for a compound.

When two or more elements combine and form a new substance with different properties, the newly formed substance is called a compound.

Elements in a Compound

The elements in a compound always combine in a definite ratio. The elements in a compound cannot be easily separated by ordinary mechanical means. However, it is possible to break up a compound into its constituents by chemical processes. This can be demonstrated by the following experiment:

Water Voltameter

The Water Voltameter is an apparatus used for

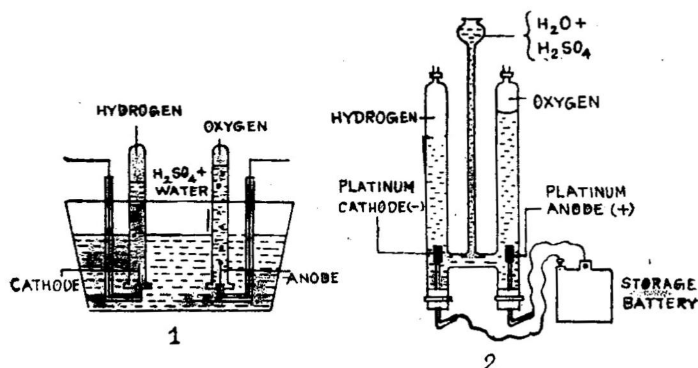


Fig. 117
Water Voltameter
1. A simple model 2. Hoffman model

decomposing water into its constituent elements. and for collecting the resultant gases.

A model of the apparatus is shown in Fig. 117. Fill the cup of the apparatus with water. Add dilute sulphuric acid (acid : water = 1 : 16) to the water. Fill two graduated test tubes with the acidified water. The test tubes should be free from air bubbles. Invert the two test tubes over the platinum electrodes in the voltameter. Connect the terminals of the voltameter to a six volt battery and pass an electric current for about ten minutes and observe what happens.

When an electric current passes through acidified water, it splits water into two gases. The two gases collect separately in the test tubes by the downward displacement of the water in the test tubes. The graduated test tubes will enable us to understand that one of the gases thus collected is twice in volume than that of the other.

What are these gases? Introduce burning splinters into the test tubes. One of the burning splinters is put out but the gas burns with an explosive **'pop'** sound. This gas is hydrogen. The splinters introduced into the other gas bursts into a bright flame. This gas is oxygen. You will notice that the gases, hydrogen and oxygen, are in the ratio 2:1 by volume.

When an electric current passes through acidified water, it splits water (which is a liquid) into its constituent elements, that is hydrogen and oxygen. These two gases are different from water in all respects. Is it then possible to get water by bringing these gases together? It is, of course, possible to obtain

water by combining these gases under suitable conditions.

The following examples will further illustrate the formation of compounds:

Put a few bright iron nails and broken pieces of a shaving blade in a china dish. Add a few drops of water and allow this to stand for four or five days. Now you will see that the nails and the pieces of blade are no longer bright and shining. On the other hand, they are covered with a brownish substance. This brown substance is iron oxide (rust). Iron reacts with oxygen in the presence of moisture and forms iron-oxide. We call this phenomenon as **'rusting'.**

Ammonia

Nitrogen and Hydrogen combine in the ratio of 1:3 and gives ammonia (NH_3) Ammonia is a compound. It is found in the atmosphere in small quantities. This gas is prepared industrially by the Haber or Cynamide process.

Ammonia is an important compound used in the manufacture of fertilizers, medicines and dyes.

Carbon-di-oxide

When carbon burns in air, it combines with the oxygen to form a gas called carbon-di-oxide. This gas is also present in the atmosphere. Carbon-di-oxide is also found in the exhaled breath of living beings. Carbon-di-oxide is formed when carbon and oxygen combine in a fixed ratio.

Methane

Another compound present in the atmosphere is methane. This gas is found in considerable quantities in the atmosphere near petroleum wells, coal

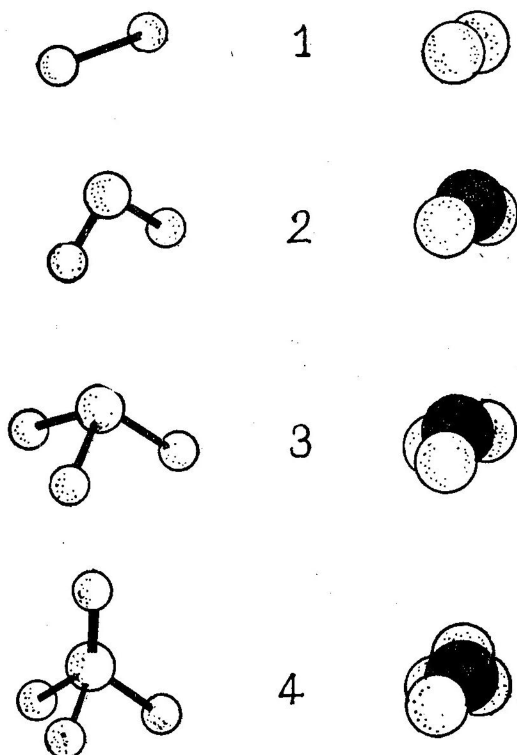


Fig. 118
Structure of Compounds
1. Hydrogen 2. Carbon-di-oxide
3. Ammonia 4. Methane

mines and marshy lands. Carbon and hydrogen combine in a definite ratio to form this gas. This gas which is highly inflammable is known as fire damp

and marsh gas. Methane is used as fuel in certain industries.

In this chapter, we have learnt what a compound is and how compounds are formed. We also learnt about water, carbon-di oxide, ammonia and methane as examples of compounds. The diagrams given in Fig. 118 will illustrate the arrangement of atoms in these compounds.

Exercise

I. Questions

1. Define a compound. Give some examples for compounds.
2. What change takes place when carbon burns in air?
3. What change takes place when magnesium burns in air? How is this product different from magnesium?
4. Describe the experiment for the electrolysis of water using a water voltameter?
5. What are the gases obtained when water is electrolysed?
6. How is water different in its properties from that of hydrogen or oxygen?
7. Explain the tests used for identifying the following:— carbon-di-oxide, hydrogen and oxygen.

8. Name the compounds formed when sodium combines with chlorine and nitrogen combines with hydrogen.

9. Write down the formula for the following compounds: water, sodium chloride, carbon-di-oxide and ammonia.

10. Name the elements which combine to form the following compounds: Water, carbon-di-oxide, ammonia and methane.

II. Do it yourself

1. With the help of your teacher set up a water voltameter using a fused bulb, a battery of electric cells etc. and find out the constituents of water.

2. Learn with the help of your teacher the working of the Hoffman's water voltameter.

3. Collect and store in small bottles samples of the following substances. Label the bottles properly.

(i) Sodium chloride (common salt)

(ii) Copper sulphate

(iii) Magnesium Sulphate (epsom salt)

(iv) Silicon-di-oxide (white sand)

(v) Potassium permanganate

(vi) Sodium carbonate (washing soda)

(vii) Sodium bicarbonate (baker's soda)

(viii) Dilute hydrochloric acid

(ix) Sulphuric acid (dilute)

(x) Nitric acid (dilute)

(xi) Calcium carbonate

4. Prepare class room exhibits of the following compounds using marbles of different colours and sizes to demonstrate their structural arrangement: water, carbon-di-oxide, ammonia, methane.

III. Pay a Visit

If there is a fertiliser factory in your area, visit it and learn about the manufacturing process of the fertiliser.

IV. Further Information

1. Water cannot be split up into its constituents by ordinary mechanical means, nor can water be formed simply by bringing the two gases, oxygen and hydrogen together.

2. However, water can be formed when the above named gases are brought together in a Eudeometer. An electric spark causes a chemical change and water is formed.

3. Read the autobiography of Thomas Alva Edison. It is interesting to note that he set up a mini-laboratory in a train and conducted his experiments there.

V. For Thought

1. Why is water acidified before electrolysis in a water voltameter?

2. What are the gases that collect at the anode and the cathode in a water voltameter?

3. Why is platinum used as the electrode in a water voltameter?

4. MIXTURES

Sulphur is an element. Iron is another element. Take sulphur and iron filings and place them in a china dish. Mix them up well and now look at the mixed substance in the china

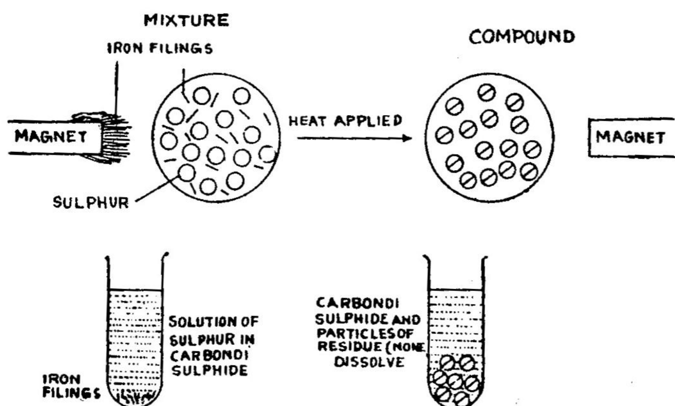


Fig. 119

dish. You will be able to identify the yellow particles of sulphur and the grey iron filings. If you use a double convex lens, you will be able to see the two substances more clearly. The constituents in the mixture can be separated in two ways. A magnet can be used to attract all the iron filings leaving behind the sulphur. The contents can be put into a solution of carbon-di-sulphide when all the sulphur will be dissolved. The iron filings will remain undissolved. **We understand that the constituents in a mixture can be separated easily using simple mechanical means The constituents in a mixture simply exist as such in a mixed state. They have not undergone any chemical change.**

Carbon and iodine are elements. Carbon, in the form of powdered charcoal and crystals of iodine are mixed and kept in a china dish. How will you separate the two constituents in the mixture? The method is simple. You know that iodine sublimates on being heated. So heat the mixture. Iodine sublimates and thus you can separate iodine. This is another example to illustrate that the constituents in a mixture can be separated by simple mechanical means.

Sand is a compound. Copper sulphate is another compound. Powder a little quantity of each of them and put the powders in a china dish. Mix them up well. Now look at the contents of the china dish through a simple microscope. You can clearly identify the constituents in the mixture. What do you understand from this? Even though both are finely powdered, sand and copper sulphate do not combine with each other to produce a new substance. On the other hand, they remain together as a mixture and they can be easily separated.

Put the above mixture in a beaker containing water and stir the contents well. You will get a blue coloured solution. Copper sulphate is easily soluble in water. Sand does not dissolve in water. This sand can easily be separated by filtration using a funnel and a filter paper. The solution can be evaporated and crystals of copper sulphate can be obtained. This is another example to illustrate the fact that the constituents of a mixture can be easily separated.

A mixture can, therefore, be defined thus·

A mixture consists of two or more different elements or compounds combined in any proportion.

A mixture can be formed by the combination

1. of an element with another element
2. of a compound with another compound and
3. of an element with another compound.

The constituents of such a mixture can be combined in any ratio. For example, a mixture can be made up of twenty grams of sulphur and five grams of iron filings or vice versa.

Separating the Constituents of a Mixture

Mixture of Salt and Sand

Take the mixture of salt and sand in a beaker and pour enough water into the beaker. Use a glass rod to stir the contents well. The salt in the mixture gets dissolved in water. But the sand does not dissolve in water. It settles at the bottom of the beaker.

Filter the solution using a suitable filter paper and a funnel. You get a solution of salt in water and the sand remains in the filter paper.

Evaporate the salt solution. Water evaporates leaving behind the salt. The constituents in a mixture can thus be separated making use of the fact that the constituents are different in their physical and chemical properties.

Mixture of Sulphur and Iron filings

How will you separate the constituents in a mixture of sulphur and iron filings? You know that iron is attracted by a magnet. Therefore, spread the mixture on a sheet of paper and bring a magnet near the mixture. All the iron filings will cling to the magnet. Sulphur will be left behind on the paper.

On the other hand, sulphur is highly soluble in carbon-di-sulphide whereas iron does not dissolve in it. The undissolved iron filings can be separated by filtering the solution. This property can be made use of in separating sulphur from the iron filings.

The following tabular column will illustrate the differences between compounds and mixtures:

Sl. No.	Compounds	Mixtures
1.	The constituents in a compound combine only in a definite proportion	The constituents can be mixed in any proportion.
2.	The constituents cannot be separated by simple mechanical means.	The constituents can be separated by simple mechanical means.

Sl. No.	Compounds	Mixtures
3.	The properties of the compound are different from the properties of its constituents	The constituents retain their properties.
4.	The compound is homogenous in character	Generally the mixture is not homogenous in character.

Exercise

I. Questions

1. What do you get when sulphur and iron are taken together in a china dish and heated?
2. What are the changes noted in the dish containing sulphur and iron mentioned above called before and after heating?
3. Define a 'Mixture'.
4. How will you illustrate that the constituents of a mixture can be separated easily by separating mixtures of (a) iodine and carbon (b) sand and copper sulphate.
5. Give two examples each for

   (i) a mixture containing two elements

   (ii) a mixture containing two compounds and

(iii) a mixture containing an element and a compound.

6. Illustrate with an example that a mixture can be formed by mixing its constituents in any ratio.

7. How will you prepare a mixture of sulphur and iron?

8. Explain how you will use a magnet to separate the constituents in a mixture of sulphur and iron.

9. How will you use a solvent like carbon-di-sulphide to separate the constituents from a mixture of sulphur and iron?

10. Tabulate the differences between compounds and mixtures.

II. Do it yourself

1. Prepare a mixture of sugar and sand and separate the constituents.

2. Prepare a mixture of sand, salt and iron powder and separate the constituents.

III. Pay a visit to

1. a paddy field during the time of harvest and observe how the grains of paddy are separated from the chaff.

2. a goldsmith's shop and observe how gold dust that gets mixed up with charcoal is again collected back.

5. AIR

The atmosphere around us contains air. Air is essential for all living beings including plants. Plants too breathe air which contains the life giving gas, oxygen. Plants take in carbon-di-oxide from the atmosphere for preparing food. In fact, in the absence of air no living being can live even for a short while.

Air is a gaseous substance. It is invisible to us. It is colourless and has no odour.

Experiment to determine the nature of air

Carefully cut out a small piece of white phosphorus kept in a bottle. Place the phosphorus in a china

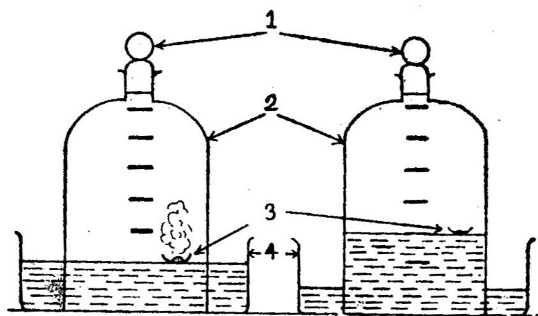


Fig. 120
Composition of air

1. Stopper
2. Belljar
3. China dish with phosphorus
4. Glass trough

dish and float it in a trough half full of water. Cover the china dish with a bell jar (fitted with a stopper).

Now divide the portion of the bell jar above the surface of water into five equal parts as shown in Fig. 120. Remove the stopper and set the phosphorus aflame with the help of a heated iron rod. At once replace the stopper and observe what happens. You will see the phosphorus burning and white fumes of phosphorus oxide belch out from the china dish and spread all over the bell jar. After some time phosphorus stops burning and the vapours disappear gradually as they get dissolved in water. As a result of this, the pressure inside the bell jar decreases. So the level of water inside the bell jar will rise. What is the rise in the level of water? You know that the portion above the water level in the bell jar was initially divided into five equal parts. The rise in level in the bell jar will now be to one out of five parts.

What do you learn from this experiment?

This experiment proves that one fifth of the air contains a gas that is helpful for substances to burn.

After this, remove the stopper and insert a burning splinter into the bell jar. The burning splinter is readily put out. This only shows that the remaining part of the air inside the bell jar does not support combustion. This gas is known as nitrogen and it occupies four fifths the volume of air in the bell jar.

So, from this experiment we learn that

1. Air contains oxygen and nitrogen in the ratio 1:4 by volume.

2. we also learn that oxygen can easily be separated from air by a simple process.

We can thus conclude that air is neither an element nor a compound. It is only a mixture. Its chief constituents are one part of oxygen and four parts of nitrogen by volume. Besides oxygen and nitrogen, air contains a few other gases in smaller quantities.

Presence of Carbon-di-oxide in Air

Fill a beaker half full with clear lime water. Attach a long rubber tube to the nozzle of a foot ball inflator. Put the free end of the rubber tube into the lime water and pump air to bubble through the lime water. What is the change that takes place?

When air passes through the lime water, lime water turns milky. It is because of the carbon-di-oxide present in air. Carbon di-oxide turns clear lime water milky. Therefore, we conclude that air contains carbon-di-oxide also.

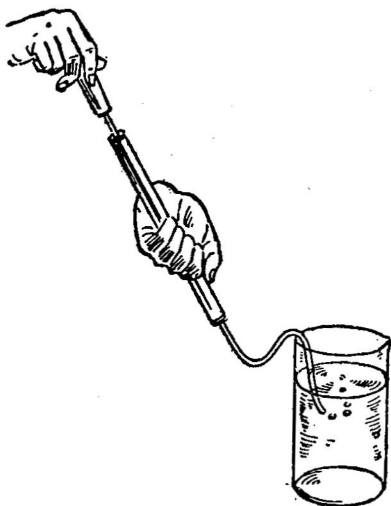


Fig. 121
Experiment to demonstrate the presence of Carbon-di-oxide in Air

Let us do the following experiment to find out what other gases (besides oxygen, nitrogen and carbon-di-oxide) are present in air.

Presence of Water Vapour in Air

Take a glass beaker and fill it half full with bits of ice. Wipe the outside of the beaker clean with a piece of cloth and cover the beaker with a watch glass. Allow the beaker with its contents to stand for some time. Watch the outside of the beaker. Droplets of water are found on the outside of the beaker. Where have they come from?

They have certainly come from the atmospheric air. The water vapour in the atmosphere, on coming

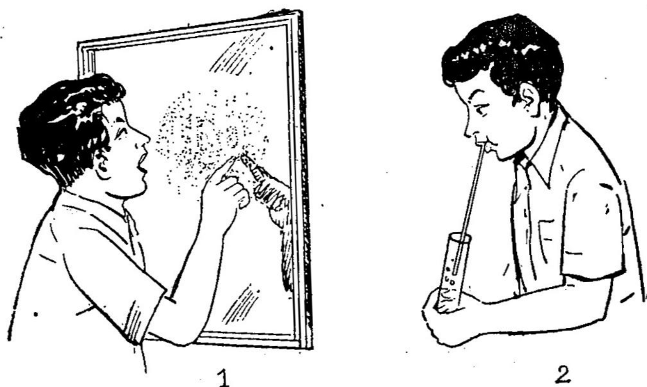


Fig. 122
Experiments to demonstrate the presence of
(1) Water vapour and
(2) Carbon-di-oxide in air

into contact with the cooler parts of the glass beaker, condenses into water.

Besides the above mentioned gases, air also contains very small quantities of inert or rare gases. Argon, Krypton, Xenon, Helium and Neon are called inert gases.

In the industrial areas, the gases emanating from the factories pollute the air around. Hence the air becomes impure. People who live in these places inhale this impure air. It will gradually affect the health of these people.

Oxidation

When an element reacts with oxygen to form its oxide, it is called oxidation. Carbon burns in air and forms carbon di oxide. Phosphorus and sulphur combine with oxygen to give their respective oxides.

Combustion or Rapid Oxidation

There are two kinds of oxidation. One is a rapid process of oxidation, otherwise called combustion. In this, the substances vigorously combine with oxygen. In this reaction, there is evolution of heat and light. It is called rapid oxidation or combustion.

Rusting or Slow Oxidation

The other kind is the process of slow oxidation. Some substances slowly combine with oxygen and moisture to form their oxides. In this slow process of oxidation, there is no evolution of heat or light. Rusting of iron is a slow process of oxidation. When materials made of iron are exposed to air and moisture, they lose their natural lusture due to rusting. When rusting takes place, iron undergoes chemical change and becomes iron oxide. The iron oxide is seen as a reddish brown coating on the iron piece.

Experiment to demonstrate 'Rusting'

Take three glass test tubes and label them, *A*, *B* and *C*. Drop carefully into each of the test tubes three or four bright iron nails.

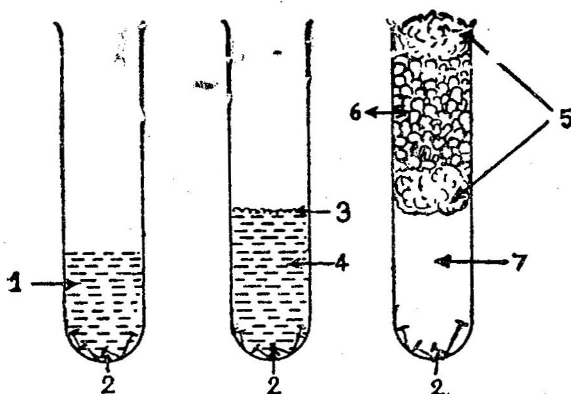


Fig. 123
Rusting of Iron

1. Water 2. Iron nails 3. Paraffin oil
4. Boiled water 5. Cotton wool
6. Anhydrous Calcium chloride 7. Air

Pour water into test tube '*A*' until the nails are immersed. Shake the tube well.

Pour boiled warm, distilled water into the test tube '*B*' until the nails are immersed and shake the test tube well. Pour some cocoanut oil or some paraffin oil over the surface of the water.

Place some cotton wool just above the nails in test tube *C* and put a little anhydrous calcium chloride on it. Put some more cotton wool on the chemical and close the top of the test tube tightly.

Leave the three specimens for a few days and then examine the iron nails in each of the test tubes.

You will notice that rusting has occurred only in test tube '*A*' and that in the case of the nails in the other test tubes, no change has taken place and the iron nails have remained unaffected.

In the test tube '*A*', the nails were in contact with water and dissolved oxygen. Hence rusting has taken place.

In the test tube '*B*', the distilled water was boiled and hence there was no oxygen. Hence there was no rusting.

In the test tube '*C*' oxygen was available to the iron nails but there was no moisture. (Why ?) Therefore the iron nails could not rust.

So from the above experiments, we can conclude that oxygen and water (moisture) are essential for rusting.

So rusting is a slow process of oxidation and there is no evolution of heat or light.

Iron is wasted in the process of rusting and this can be prevented by (i) keeping it out of contact with oxygen and moisture (ii) coating it with paints or tar or by coating it with metals like zinc, chromium etc.

Exercise

I. Questions

1. Describe an experiment to show that air is a mixture.

2. What will happen if the atmosphere around us contains only oxygen or nitrogen?

3. Mention the test for identifying the following gases: nitrogen, carbon-di-oxide, oxygen.

4. Describe an experiment to show the presence of cardon di-oxide in air.

5. How do you account for the presence of water vapour in air? How will you prove its presence in air?

6. Why do wet clothes take longer time to dry in winter than in summer?

7. Some people live in industrial areas and in crowded places with heavy motor traffic. How will these factors affect the health of the people?

8. What is meant by oxidation? Give examples.

9. What are the two kinds of oxidation?

10. Explain how "combustion" is a kind of oxidation.

11. What are the conditions under which rusting takes place? Describe an experiment to illustrate the occurrence of rusting of iron.

12. How can rusting be prevented?

13. Compare and contrast - "combustion and rusting".

II. Do it yourself

1. Take some clear lime water in a beaker. Blow air into the lime water through a tube. Observe what happens.
2. Add soda water to clear lime water kept in a beaker. Observe what changes take place.
3. Take some bright nails and a few razor blades in a beaker. Add a few drops of water and keep the material undisturbed in a place for four or five days. Then observe what changes have taken place.

III. Know this

1. Air has been liquified. Oxygen and nitrogen have also been liquified.
2. Neon gas is filled in the electric bulbs and used on the runway of the airports. Argon is used to fill up electric bulbs. Helium is used to fill up balloons and aeroplane tyres.
3. The composition of air changes from place to place. The oxygen content becomes lesser and lesser as we climb up a mountain. Hence mountaineers use cylinders containing oxygen (Fig. 124).

IV. For Thought

1. Why does one suffer from nausea while leaving a well covered theatre especially after a show in the afternoon?

2. Sleeping under a tree during night is harmful. Why?



Fig. 124

6. SOLUTIONS

Take a beaker half full with water. Add a teaspoonful of sugar crystals to it. The sugar dissolves in the water and no particles of sugar are visible. Taste a little of the liquid and you will find that it is sweet. It is because the sugar crystals have dissolved

completely and spread uniformly to every part of the water. Solid sugar has now become sugar solution.

Sea water contains dissolved salts like magnesium sulphate, sodium chloride, magnesium chloride etc.

Salts like copper sulphate, potassium permanganate, sodium carbonate and sodium bicarbonate can be dissolved in water to prepare solutions as described above.

A solution possesses the same properties of the substance that is dissolved in it (*i.e.*) in colour, smell and taste. Solutions are homogenous in nature. This property of homogeneity can be illustrated by the following experiment.

Homogenous Nature of Solutions

Put some crystals of potassium dichromate in a beaker containing water and stir well with a glass rod. Soon the water turns orange. The solution not only turns orange but also shows all the qualities of the substance dissolved in water. It is because the crystals of potassium dichromate have broken down into tiny particles and spread themselves uniformly throughout the solution. This is called the homogenous nature of solutions.

Solute and Solvent

When we talk of solutions, we very often use terms like 'solvent' and 'solute'. Let us assume that a solid dissolves in a liquid. For instance, let us dissolve some sugar in water.

Now the water that dissolves the sugar is termed as **'solvent'** and the sugar is termed as **'solute'**. Most of the solutions are obtained by solids dissolving in liquids.

The resulting mixture of sugar (solute) and water (solvent) is called a **solution**.

When a solute dissolves in a solvent, the resulting mixture is called a solution.

Water occupies a special place among solvents. Water is called the "universal solvent". It is called so because it can dissolve a number of solid substances. Some solids do not dissolve in water. Carbon, sulphur and phosphorus may be cited as examples for substances that do not dissolve in water. However, they are soluble in some other suitable solvents.

Factors that hasten the Solubility of Solids in Liquids

Take a beaker and pour some distilled water into it. Put some crystals of alum into the water. After a few minutes look at the bottom of the solution. You will find that a major portion of the alum crystals have dissolved in water and a small portion of the salt remains undissolved. Now take a glass rod and stir the solution. You will notice that the undissolved alum dissolves quickly and completely. Should still a portion of the alum remain undissolved, heat the solution. At the same time keep on stirring. Now all the alum crystals will get dissolved.

Moreover, if the crystals are powdered and added to water, the alum will dissolve very quickly. we, therefore, understand that

1. the solute should be powdered well before being added to solvent.
2. the solution should be constantly stirred.

and 3 the solution should be heated.

These three factors enable the solute to dissovle in the solvent easily and quickly.

Solubility and Changes in Temperatures

Take two beakers and fill them half full with water. Add 1 gram of ammonium chloride to the water in one of the beakers. Place the beaker in the palm of your hand. You will feel that the solution is cold.

Add one gram of sodium hydroxide to the other beaker and stir well. Place the beaker in the palm of your hand. You will feel that the solution is warm.

What do you infer from this?

When a substance dissolves in water, heat is either absorbed or given out.

Solubility of Salt in Water

Fill a beaker half full with distilled water. Add a spoonful of finely powdered sodium chloride to the water and stir well. The salt dissolves freely and goes into the solution. Add another spoonful of the salt and stir until all the salt is dissolved. Repeat this till the salt is completely dissolved. Go on adding salt to the solution until a small quantity of the salt remains undissolved in spite of vigorous stirring.

When a definite quantity of the solvent can no longer dissolve any more quanitity of the solute at a particular temperature, the solution is said to have reached the saturation limit. Such a solution is called a **saturated solution.**

When a solvent is capable of dissolving more and more solute, it is said to be an **unsaturated solution.**

Solubility

The solubility of a substance is the amount (mass) of the solute that will dissolve in 100 grams of the solvent at a particular temperature.

Generally when temperature increases, the solubility of a substance increases. The temperature should always be indicated when the solubility is mentioned. For instance, the solubility of epsom salt (magnesium sulphate) at 0°*C* is 26·9 grams, at 30°*C* 40·9 grams, at 60°*C* 55 grams and at 100°*C* 73·8 grams.

Preparation of Crystals from Solutions

Do you know how common salt is obtained from sea water? Sea water is stagnated in fields close to the seashore and is allowed to evaporate. Salt is left behind. Dissolved salts are estimated to be found in sea water to the extent of 3·6% by weight. Of this quantity 75% is common salt (sodium chloride).

The same principle can be used in the laboratory to prepare crystals of certain salts. The saturated

solution of a salt may be evaporated by heating and the crystals of the salt will be left as a residue. This method is called **crystallization.**

Preparation of Crystals of Common Salt in the Laboratory

Take a 50 ml. glass beaker and pour 20 ml. of distilled water into the beaker. Add common salt to the water and prepare a solution of the salt.

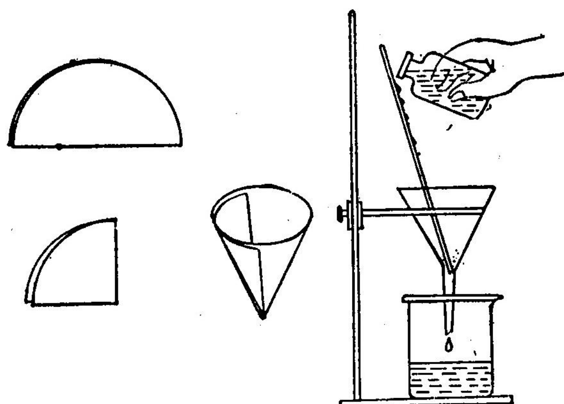


Fig. 125
Filtration

Filter the solution as shown in the figure using a funnel and a filter paper. The filtrate is collected in a china dish. Keep the china dish on a tripod stand over a wire gauze. Stir the solution to prevent spurting. When a crust is formed on the surface of the solution, stop heating. Place the china dish on the asbestos sheet and allow it to cool. When the contents are cooled, decant the mother liquid. Remove the crystals from the china dish with the help of a glass rod.

Place the crystals between the folds of the filter paper and gently press them to remove moisture. Choose a few well formed crystals and examine their appearance and shape.

Crystals of a particular salt have a definite shape which is characteristic of that crystal. The crystals have many flat surfaces. For example, a crystal of the common salt is cubical in shape. The crystals of alum will be tetrahedron in shape.

Solutions and Electrical Conductivity

Metals are good conductors of heat. Aluminium and copper wires are used for conducting electricity. Generally non-metals are non-conductors. What about compounds? Do they conduct electricity?

Some compounds, in the form of solutions, in water conduct electricity.

Conductivity of Solutions-Experiment

Fill a beaker three fourths with a solution of copper sulphate. Place two clean copper plates in the solution and connect the copper plates in series with a six-volt battery, a torch light bulb and a plug key as shown in Fig. 126. Plug the key and see if the bulb glows.

Repeat the experiment by replacing the copper-sulphate solution one after the other with sugar solution, salt solution and distilled water. Note down in your note book whether the bulb glows or not in each case.

From the above experiments, it will be seen that solutions of copper sulphate and salt are good conduc-

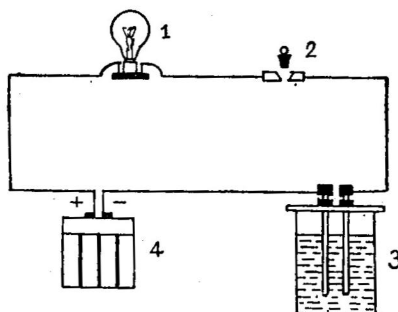


Fig. 126

Electrical conductivity of Solutions

1. Bulb
2. Plug key
3. Beaker containing solution
4. Battery

tors of electricity. Sugar solution and distilled water do not conduct electricity.

Separating the Solute and the Solvent from a Solution

When a solution of salt is heated to prepare crystals of the salt, the solvent (water) evaporates and goes into vapour. We are not able to get the water in this process. When it is required to get both the solute and the solvent, it is necessary to use a condenser. The condenser enables the solvent (in the state of vapour) to condense into liquid. This process is called **distillation.**

The Method of Distillation

Fill a distillation flask half full with the saturated solution of common salt. Close the mouth of the flask with a one holed rubber cork. Insert a thermo

meter into the flask through the hole. The thermometer should not touch the liquid. Fix one end of a condenser to the outlet of the flask as shown in the figure. The other end of the condeser is kept in a receiver.

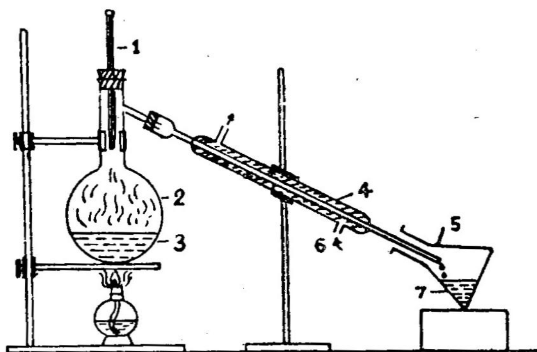


Fig. 127
Distillation

1. Thermometer
2. Distillation Flask
3. Saturated solution
4. Liebig condenser
5. Receiver
6. Cold water entering the condenser
7. Distilled water

Fix the above apparatus to a stand and heat the flask. The water in the solution vapourizes and passes through the condenser. The condenser is fitted to a water tap. Water flows all around the central glass tube. The water vapour now condenses due to the cold water around and collects drop by drop into the receiver.

When the solution (in the flask) reaches a semi-solid state, stop heating and transfer the residue in the flask to a china dish. When the residue is further heated, dry crystals of the salt are collected.

This method of distillation can be used for separating a solution containing two liquids of different boiling points.

Solution of Gases in Liquids

You know that gases are soluble in liquids. For example, we can think of carbon-di-oxide filled aerated beverages. When you attempt to open an aerated bottle of beverage, you must be careful. Why?

Carbon-di-oxide is only sparingly soluble in water. But when carbon-di oxide is dissolved in water under high pressure, its solubility increases.

Living organisms such as fish, which live in water require oxygen. Oxygen is soluble in water. Thus these living organisms get their supply of oxygen.

Fill three fourths of a beaker with water. Invert a funnel inside the water in the beaker. Place an inverted test tube completely filled with water over the stem of the funnel as shown in the figure. The test tube should be free from air bubbles. Heat the beaker to 60°C. As

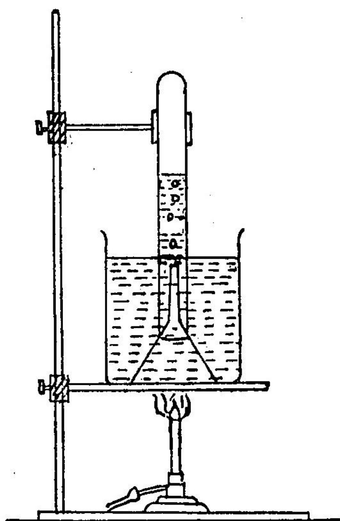


Fig. 128

Experiment to show that air is dissolved in water

you heat the water, you will observe air collecting at the top of the inverted test tube. It is only the air that is dissolved in water that escapes when heated and collects at the top of the test tube. We learn from this that air is dissolved in water. We also learn from this that the solubility of a gas in liquid decreases as the temperature increases.

Some gases freely dissolve in water. For example, ammonia gas and hydrogen chloride gas possess this property.

Solubility of Ammonia Gas in Water

Collect ammonia gas in a 250 ml. flask by heating ammonium **Cloride** and calcium hydroxide. Close the mouth of the flask with a one-holed rubber stopper. Insert a thin long glass tube with a narrow end into the gas filled flask. The narrow end of the tube should be inside the flask. This arrangement of apparatus should be fixed to a stand as shown in the figure. The other end of the tube should be inside a beaker

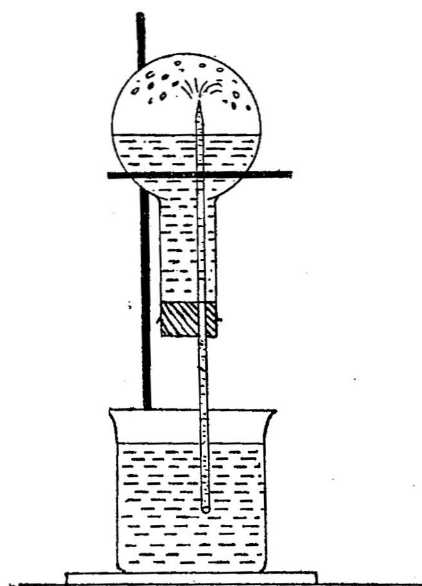


Fig. 129

Experiment to demonstrate that Ammonia dissolves freely in water

containing red litmus solution. Observe what happens after a few minutes. Why?

Uses of Solutions in Our Daily Life

We make use of solutions in our daily life in one way or another. For example, we take medicines in the form of solutions. Some of the foodstuffs we consume are in the form of solutions. Water is a good solvent. It dissolves and washes away dirty materials around us.

Solutions play an important role in the metabolic processes of plants and animals. Fertilizers like ammonium sulphate, super phosphate and urea are added to the soil to increase fertility. But these fertilizers cannot be directly taken in by the plants. They dissolve in water and these solutions are absorbed by plants.

Can you think of more examples regarding the use of solutions in our daily life?

Exercise

I. Questions

1. Explain with suitable examples the terms solute, solvent and solution.
2. What do we mean by the homogenous nature of the solution?
3. Why is water called the universal solvent'?
4. What are the factors that increase the solubility of a solid in a liquid?

5. Explain with examples that heat may be absorbed or given out when some chemical substances dissolve in water.

6. What is the difference between a saturated solution and an unsaturated solution?

7. How will you find out whether a given solution is saturated or unsaturated?

8. What is crystallization? How will you prepare crystals of alum in the laboratory?

9. Describe an experiment to demonstrate the property of electrical conductivity of solutions.

10. Explain the principle involved in the method of distillation.

11. Explain with a neat diagram how the solute and the solvent can be separated during distillation.

12. How is the solubility of a gas in a liquid affected by heat and pressure?

13. Describe an experiment to show that air is dissolved in water. Draw a diagram of the apparatus used.

14. How will you prove that ammonia gas is freely soluble in water? Draw a neat diagram of the apparatus used.

15. Is sea water a mixture or a compound? Explain.

16. If a fish is put in a tub containing cold distilled water, it dies. Why?

17. Sea water is not suitable for drinking Why?

18. Mention the names of some of the solutions we use in our daily life.

19. If more than one salt is put in a liquid at the same time, will they dissolve? Explain with suitable examples.

II. Do it yourself

1. Add common salt and some sugar separately to (a) water (b) kerosene. Find out whether they dissolve in these liquids.

2. Add powdered naphthalene to (a) water (b) kerosene and examine whether they dissolve in these liquids.

3. Prepare saturated solutions of alum or copper sulphate. Take a small crystal of alum or copper sulphate, as the case may be, and suspend it in the solution with the help of a thread. Observe what changes take place after a few days.

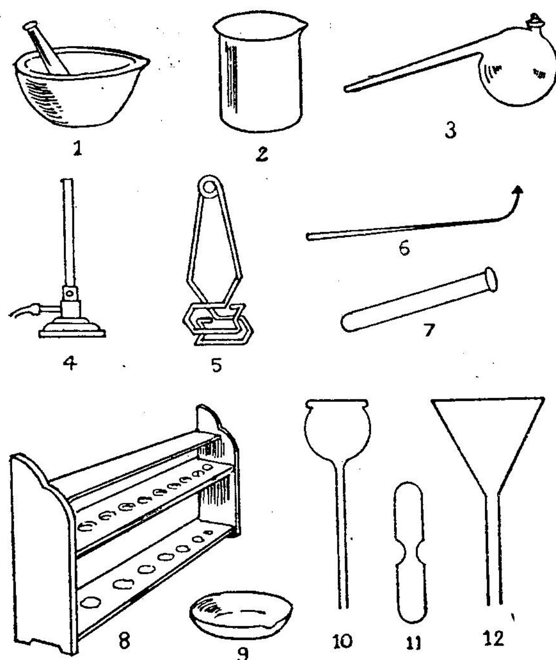


Fig. 130

Apparatus and glassware used in the chemistry laboratory

1. Pestle and Mortar
2. Beaker
3. Retort
4. Bunsen Burner
5. Test tube Holder
6. Blow Pipe
7. Test tube
8. Test tube stand
9. Evaporating Dish
10. Thistle funnel
11. Spatula
12. Funnel

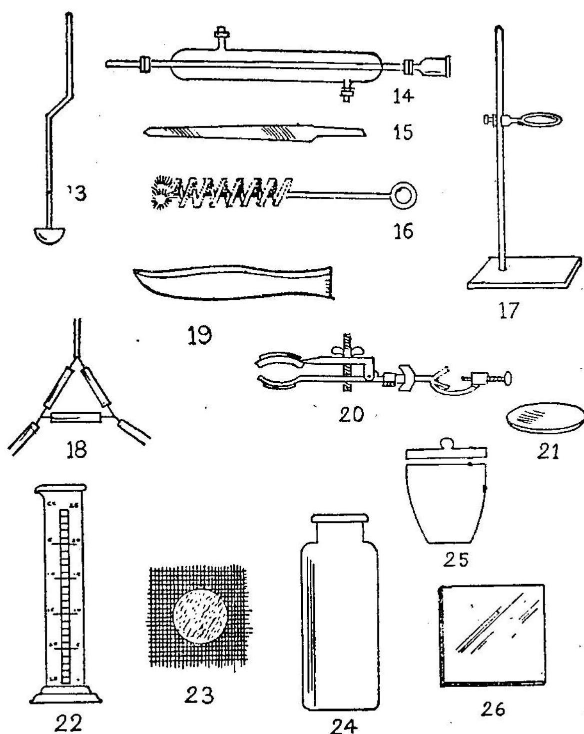


Fig. 131

13. Deflagrating Spoon
14. Condenser
15. File
16. Test tube brush
17. Ring stand and Ring
18. Clay-pipe triangle
19. Forceps
20. Burette Clamp
21. Watch glass
22. Graduated Jar
23. Wire gauze with asbestos centre
24. Wide mouthed gas bottle
25. Crucible
26. Glass plate

Part III BIOLOGY

1. ENVIRONMENT

The land surface in which we live can be divided into various regions. Some regions are high mountains; some are plains; some are valleys and some other regions are dense forests. The climatic conditions on the land vary from place to place; for example, we come across polar regions with freezing temperature; we come across regions with higher temperature and certain other regions with moderate temperature. The atmospheric pressure, the speed of air, etc., also differ from place to place.

Therefore, the animals and plants living in this world have to adapt themselves to the environment in which they live. An animal has to put up with the cold ice if it happens to live in such an environment. A plant that lives in the desert has to bear the very hot climate. This type of behaviour of animals and plants adjusting themselves according to the places where they live is called the adaptation to the environment.

The environment can be broadly classified under two categories — the living and the non-living environments. The places where the living beings live, like land, water and air are called non-living environments. The plants and animals which are

seen around a living being make up the living environment. The living environment depends upon the non-living environment.

The living beings that are not capable of adapting themselves to the environment become extinct in their struggle for existence. The living beings that are capable of adapting themselves to the environment survive in the struggle for existence and they alone continue to live.

How plants and animals are adapting themselves to the environment is dealt with in detail in the following chapters.

Exercise

I. Questions

1. What are the various regions of the land?
2. What is meant by adaptation to environment?
3. What is the necessity for living beings to adapt themselves?

II. Fill in the blanks

1. The places where the animals and plants live like land, water, air, etc. are called ——————————
2. The living environment is ——————

2. ADAPTATIONS OF PLANTS

If you are asked to make a list of the living beings that are around you, you will note down dog, cat,

sheep, cow, cocoanut, plantain, etc. If you are asked to classify them according to your knowledge. you may do it as follows:

You may classify plantain and cocoanut under one group and dog, cow, sheep, cat, etc. under another group. What is the basis of this classification?

The first group of living beings can be called plants and the other animals. The animals are capable of moving from place to place in search of food. If cows are affected by the heat of the sun, they go in search of a shady place. A sleeping cat wakes up on hearing the sound of our footsteps and goes out to a different place. But the plants have no movements like animals. If a particular environment is not suitable to them, they cannot move to a different place. So the plants adapt themselves with certain modifications in their structures. These modifications are due to four factors: They are **climate, sunlight, water** and **wind.** Let us investigate how these factors are responsible for the adaptation of plants in order that they could survive.

1. Climate

The plants require about 20°*C* to 40°*C* for their normal growth. Cold regions are not suitable for their growth.

The dehiscent fruits disperse their seeds by explosion in sunlight. The stomata of the leaves expand and contract according to the energy received from the sun. The blossoming of the flowers is due to change in climate.

2. Sunlight

The important function of the plants is to prepare food. The chlorophyll found in the leaves of plants prepare food by using water and carbon-di-oxide in the presence of sunlight. This process is called **photosynthesis.** Sunlight is essential for this formation. So the leaves have different arrangements in order to secure sunlight.

3. Water

95% of the plant body is composed of water. Water affects all life processes directly. The basic living function of the plant is to absorb the nutrient water from the soil. The fertility of the soil depends upon the rain fall. So the quantity of water controls the growth of the plants. The rate of transpiration, respiration, etc., are influenced by the amount of water available. The germination of seeds and the establishment of seedlings are directly affected by water.

4. Wind

A strong wind creates havoc to plants. The dry wind increases the rate of transpiration in plants. The tender saplings wither away in dry wind. Certain plants are adapted to withstand strong wind. For example, (Fig 132) the cocoanut trees have long petioles and small leaves on either side and each leaf has a strong midrib. This will withstand strong winds. The wind also helps the dispersal of seeds to long distances. *e.g.* **Calotropis.**

All the factors mentioned above reveal that the living places of plants are not similar in all respects.

Certain places are dry without water; some places are water logged; and some places have more wind and high temperature. Therefore, plants are classified



Fig. 132
Leaves of the cocoanut tree withstanding strong winds

into three categories according to the places where they live. They are hydrophytes, mesophytes and xerophytes. Let us study how these plants have adapted themselves to the places of their living.

Exercise

I. Questions

1. What are the important reasons for the adaptations of plants?

2. How are plants classified according to their environment?

3. Give two examples to explain that climate helps the plants in their life activity.

4. What is meant by photosynthesis?

5. How is the leaf of a cocoanut tree different from those of other plants? Give reasons.

II. Fill in the blanks

1. For the normal growth, plants require about ____________________.

2. ____________% of the weight of the plant is water.

3. ________, ________, ________ and ________ are essential for photosynthesis.

III. For Thought

Only a few plants are found in polar regions. A large number of plants are found in regions with moderate temperature. Why?

3. ADAPTATIONS OF WATER PLANTS

Have you ever been to a tank bund and observed the plants living in it? Have you seen some tanks fully covered with **water hyacinth**? Have you ever shown curiosity to study these plants which produce blue flowers?

Water hyacinth is a natural floating plant. It is found in abundance in ponds, lakes and canals.

The whole plant floats on the surface of the water. The root system grows from a short stem. It prevents the plants from submerging. When the water

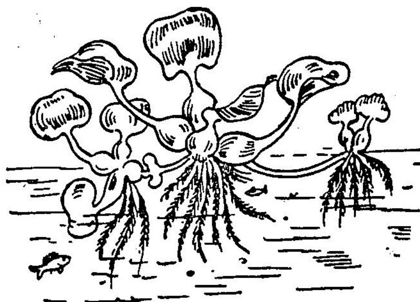


Fig. 133

Water hyacinth

in the pond or canal dries up, the roots get fixed in the soil and absorb water from the soil. Are you able to see the stem? It is very difficult to identify the stem, because it is narrow and short. The whole stem is covered with leaves. Two or three shoots can be seen from the stem. When these shoots mature, they grow separately. This process is called off-set. A water hyacinth gives rise to many off-sets rapidly and therefore it spreads throughout the water surface. The growth of water hyacinth in lakes and canals is a hindrance for transport.

The leaf of water hyacinth has a greenish stalk which is long and spongy. There are air spaces in the stalk. So the plant floats. The function of the leaf stalk is to prepare food by photosynthesis. The flowers are blue. Insects are responsible for cross pollination in these plants.

Have you seen a **lotus** or a **lily** floating in water? Do you find the structure of the lotus or water lily similar to that of water hyacinth? No, water hyacinth floats freely. But lotus and lily are floating on the water surface while the root system is buried in the

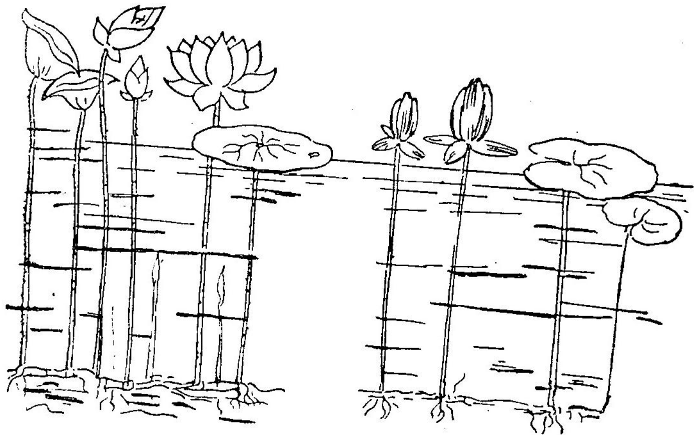


Fig. 134
Lotus and Lily

soil. These plants are found in slightly deep water surfaces. They are able to live in water and not on land because their leaves are able to float and the leaf stalks are too weak to support the blades of the leaves. The stem is modified into a small rhizome and the roots are poorly grown. The stomata are found in the leaf surfaces and are coated with a waxy substance. The leaves are very well developed. The flowers blossom on the surface of the water and they are protruding a little over the water surface. Mostly insects help in pollination.

Besides these floating plants, there are some water plants which are submerged in water. Examples

of these plants are **hydrilla, vallisneria, elodia, chara** etc. Their roots are buried in the soil. The stems are thin and flat like a tape. They contain air spaces. The leaves are usually small and are very much

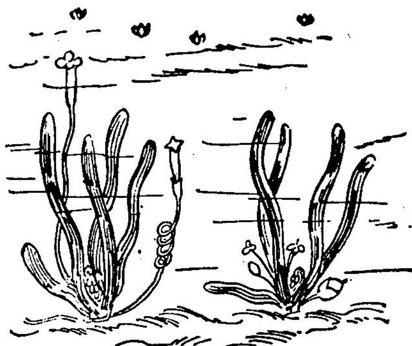


Fig. 135
Hydrilla

branched, as in **Utricularia.** The stomata are very few. The surface of the leaves does not contain wax coating. These adaptations help them to withstand the waves in the water. They breathe the oxygen dissolved in the water. Pollination takes place through water.

Thus we find the water plants completely or partially submerged in the water or freely floating on the water surface. These water plants are called **hydrophytes.**

In short, in hydrophytes, the plant body is greatly reduced and the stem is modified into a small and relatively less branched rhizome. The **lemna** shows extreme reduction in the size of the plant body. The roots are either totally absent as in **Wolffia** or

very much reduced. In free floating plants, the root caps and root hairs develop prominently. The leaves are generally thin, small and reduced in submerged plants. In free floating plants, the leaves are well developed. In partly submerged plants, the flowers are usually produced on the surface of the water. Pollination is effected by water or by aquatic insects and birds. Vegetative reproduction is common.

Anatomically, the plants exhibit development of air spaces in the tissues. The stomata are absent in the submerged plants. Chlorophyll is found in all the tissues, throughout the plant body. Mucilage canals are present; they secrete mucilage. It helps to protect the plant body from decay under water.

The gases produced during photosynthesis and respiration are partly retained in the air chambers to be utilised when required. There is no transpiration in the submerged plants but in the floating plants, excessive rates of transpiration have been observed.

Having studied the different types of water plants, can you infer why these water plants have different adaptations? Hydrophytes show considerable variations in their requirements of water. They require large quantities of water and they cannot survive outside the water. The quality of oxygen necessary for these plants is less in water. The sunlight is not available under water. Therefore, these plants are adapted or fitted for a certain type of environment.

The submerged plants and free floating plants are deposited on the surface of the soil after their death. As a result of this, the depth of the pond

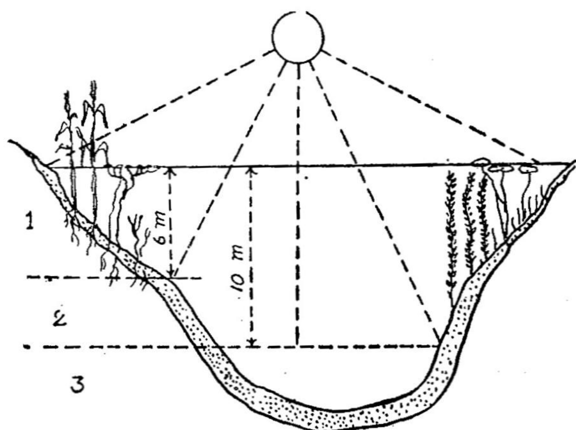


Fig 136

Plants growing in different depths in a pond

is reduced. In such a place, plants like **Scrypartypa, Sagittaria, Lymnopilla** etc. grow well. If more and more of the decayed leaves are deposited and when the pond becomes dry, grass varieties like carex, **cypres** and **juncus** grow well.

Let us study how these plants are helpful to the community in Lesson 5.

Exercise

I. Questions

1. What is the necessity for adaptations in hydrophytes?
2. State the types of hydrophytes.

3. Give two examples for free-floating plants. Why are they called so?

II. Answer in a few words or sentences

1. Give two examples for submerged plants.
2. Name a few plants growing at different depths in tanks.
3. Where are the stomata found in the leaf of lotus?
4. Why does the leaf of lotus not get wet with water?
5. What is the special structure found in the swollen portion of the leaf of water hyacinth to help in floating?

III. Fill in the blanks

1. The gas that comes out during respiration is rich in ____________
2. The gas that comes out during photosynthesis is rich in ____________
3. Cross pollination is brought about by ______ ____________ in floating hydrophytes.

IV. For Thought

Have you observed hydrilla and other submerged water plants kept in fish tanks? Can you explain this?

4. ADAPTATIONS OF ANIMALS IN WATER

When you went to observe the tank bund to study the water plants, you would have noticed certain animals also living in it. Have you observed the frogs, leaping and jumping on the banks of the tank? Have you observed the fishes swimming beautifully in water?

Fishes are well adapted to live in water. Their streamlined bodies are suited for swimming. Water medium affords much greater resistance to the

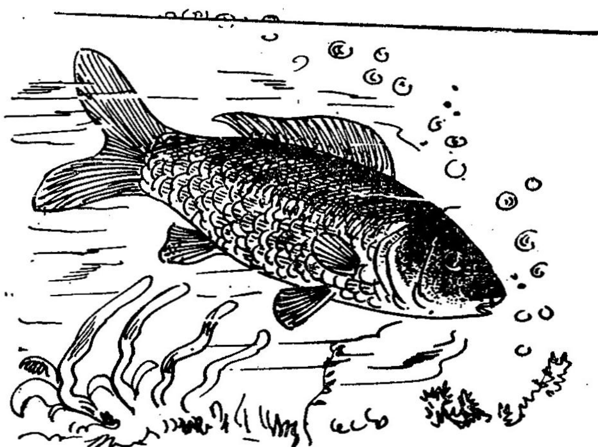


Fig. 137

Fish

animals moving in it. Therefore, the streamlined body offers the least resistance during movement. In addition to the muscular movement, swimming is greatly aided by the action of the fins. The fins which are seen on the front portion of the fishes

act as 'balancers'. Don't you find the fishes changing their direction while swimming? The fins found at the tail region of the fishes act as 'rudders'.

Apart from these common fishes, there are certain other fishes, which have evolved swim bladders; they are filled with gas. By controlling the gas content in the swim bladder, the fishes either rise to the surface of the water or go down into the water. Moreover, the fishes are provided with gills for respiration. Well developed scales are also present to protect the body against the action of water

Have you seen **frogs** swimming in water? They don't have the fins. Yet they swim. It is because the hind limbs are webbed. Frogs are basi-

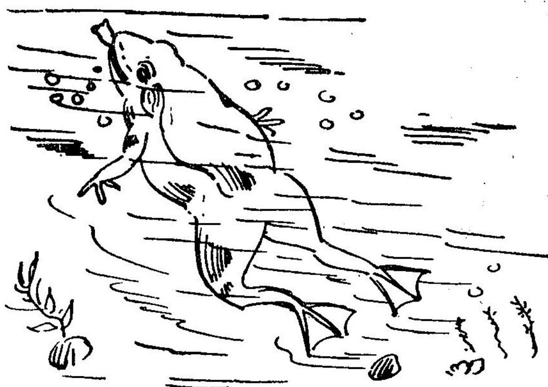


Fig. 138
Frog

cally aquatic animals. Though they show varying degrees of adaptation to live on land, they lay their eggs and pass through their early development in

water. But the adults are air-breathing and wander over the land. Since the skins must be kept moist, they are confined to the vicinity of water.

If you observe closely the animals in the pond, you can notice soft shelled turtles, water snakes etc. in deep places. The water snails, leeches, crabs, spiders etc. are found near the shore.

Why do the birds come to the tanks? You might have come across a **king fisher** diving suddenly into

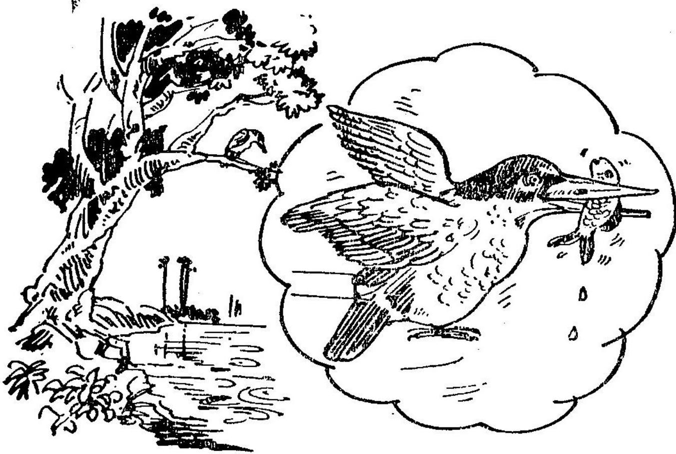


Fig. 139

King Fisher

the water to catch the small fish and frogs that come near the surface of water. The **herons** and **egrets** come and sit around the tanks. They are able to walk in the shallow water with their long legs; the **ducks** are able to swim in water by their webbed feet.

The pond is a breeding place for mosquitoes. They lay their eggs on the surface of water which are capable of withstanding any climate.

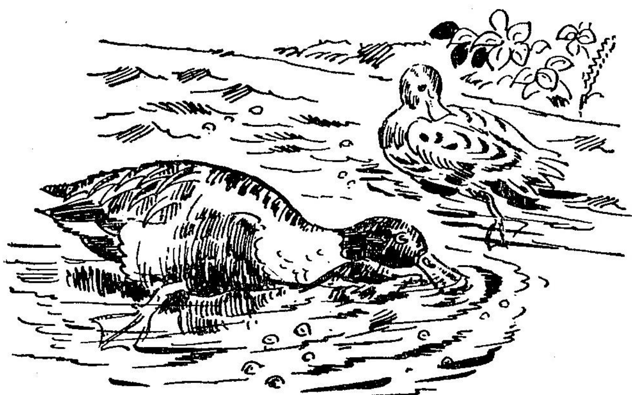


Fig. 140

Ducks

In addition to the animals described above, you can come across different kinds of insects. The

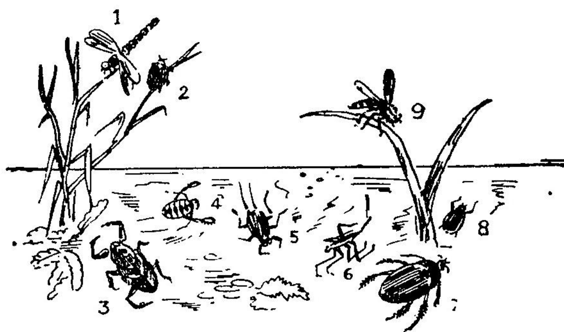


Fig. 141

Insects living in and around water

1 Dragon fly 2. Jean beetle 3. Diving beetle
4. Water boatman 5. Water Scorpion 6. Water walking stick
7 Great water beetle 8. Whirligig beetle 9. Wasp

insects living in water are of two kinds. They are **water bugs** and **water beetles.** Let us learn something about them.

1. Water Bugs

The water bugs consume both the living and dead animals as food. They have wings but they do not use them. **Water boatman, water scorpion, water stick** are some of the bugs found in water.

(a) Water Boatman

It is adapted for swimming. It strikes the hind legs and dives forward in water. It is fond of swimming upside down. Small fishes and tadpoles are its food.

(b) Water Scorpion

It looks like a dried leaf on the water surface. It will appear to be still to catch its prey. With the help of its forelimbs, it sucks the body fluid of the tadpoles and small fishes.

2. Water Beetles

Water beetle catches its prey and munches it. The popular water beetle is 'whirligig beetle'. It keeps on chasing each other throughout the day. Worms, tadpoles and insects are its food.

All the animals that live in water are able to swim and change their places. The temperature in the tank water is less during mornings and evenings but it is maximum during noon time. Therefore, the animals move near the shores during mornings and evenings. They reach the bottom during mid-

day. They are able to utilise the dissolved oxygen for respiration through their body surface. Thus the animals are adapted to the environment in which they are living.

The living space of tanks and ponds can be vertically stratified in relation to light, water pressure and temperature. In a tank there are three well recognised horizontal zones namely the upper zone, the middle zone and the bottom zone.

The upper zone contains water rich in oxygen. The water is warm due to sunlight. Therefore, rooted plants could be seen in this zone. In the middle zone also the light can penetrate. At the bottom of the middle of the zone, the rate of photosynthesis

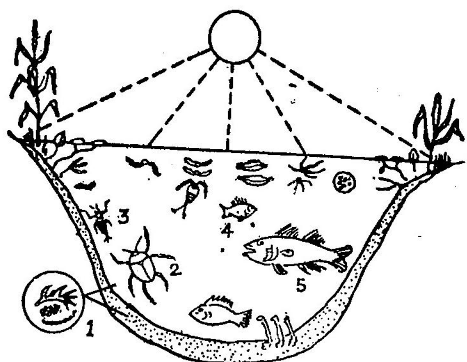


Fig. 142
Interdependance of Animals living in Water

1. Food producers
2. Primary consumers
3. Secondary consumers
4 & 5. Tertiary consumers

is equal to the rate of respiration. The bottom zone is the deep area beneath the middle zone where sunlight cannot penetrate.

The **upper zone** contains great concentration of animals. Dragonfly; insects, tadpoles, worms, snails etc. are found in this zone.

The **middle zone** is the main region where many animals live. The protozoans, snails and frogs occupy the middle zone. Slow moving animals are not found in this zone.

The **bottom zone** consists of bacteria, fungi, bloodworms and earthworms. These animals are capable of surviving in low oxygen and little light. Most of the largest fishes are living in this zone.

Where will these animals go if the tanks or ponds become dry in summer?

The animals living in the tanks and ponds may die for want of water, but nature prevents such death. Fishes lay thick shelled eggs; Amoeba weave a cocoon around it and lives inside it; the snail hibernates. As soon as the tank fills up with water, they begin to lead their normal life.

Let us study in the next lesson how the animals and plants found in the ponds are interdependent and how they are helpful to the community.

Exercise

I. Questions

1. Mention two water bugs found in the tanks.
2. How are the water beetles different from water bugs?

3. How are the fishes adapted to live in water?
4. State the names of the birds frequenting the tank. Why should they do so?
5. What animals do you find in the middle zone of the living space of the tanks?
6. Describe with suitable illustrations how nature prevents death of animals during summer in tanks.

II. Fill in the blanks

1. The animals found in the bottom zone of the tanks are ————————.
2. The water bug that looks like a dry leaf on the surface of the water is ——————.
3. Water boatman is more interested in —— ——————.
4. The gas, that comes out during respiration is rich in ————————.

III. Classify the following Animals

water boatman, water scorpion, water stick, whirligig, great water beetle.

1. Water bug : ————
2. Water beetle : ————

5. INTER-DEPENDENCE OF LIFE IN WATER

You have already learnt about the plants and animals that live in a tank or a pond. They live

as a community by depending upon each other. No living being in this world can live independently.

For living in this world, animals and plants need food. The green algae, the mosses, the floating plants, the submerged plants prepare food in the presence of sunlight by mixing carbon-di-oxide and water. The food prepared by these plants are eaten by animals living in water. This we call 'food cycle' or 'food web'.

The **water insects,** the **tadpoles, small fish** that live on the water surface eat and live on these plants.

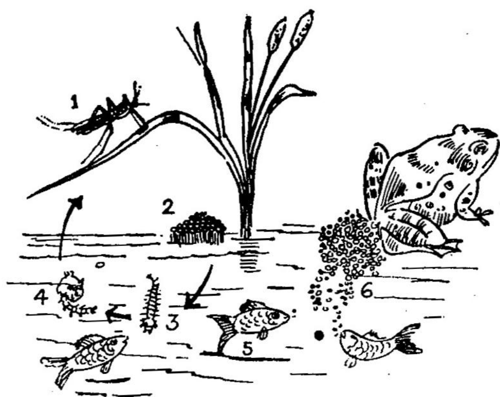


Fig. 143

Inter-dependence of life in water

1. Mosquito 2. Eggs of Mosquito 3. Larva
4. Pupa 5 Fish 6. Eggs of Frogs

The **big fish, crabs, tortoises, snakes** etc. live by eating the small fishes and tadpoles.

In the previous lesson, you studied that the birds go to the tanks. The **king fisher** dives to catch the fish

and frogs that come near the surface of water. The **white egrets** have long and sharp beaks to catch the insects, worms, fish, frogs and tadpoles.



Fig. 144
Interdependence of life

The **ducks**, while swimming in water, eat small insects and worms found in the mud. They are able to catch the small insects found in the mud by prying them with their beaks and filtering the water through the holes.

Have you ever seen the health authorities of your town putting some fishes in your well? Have you ever thought why they do so?

The mosquitoes lay eggs on the surface water of the tanks, ponds and wells. These eggs are hatched and larvae come out which finally emerge as mos-

quitoes. If all the eggs become mosquitoes, diseases like filaria and malaria will spread everywhere. In order to prevent this, certain fishes are reared in the tanks and ponds. They eat the eggs and larvae. Thus the fishes help the community in destroying the mosquitoes.

The fungi and the bacteria that live in the bottom of the tanks decompose the dead plants and animal bodies. They are called decomposers. They generally help in enriching the soil.

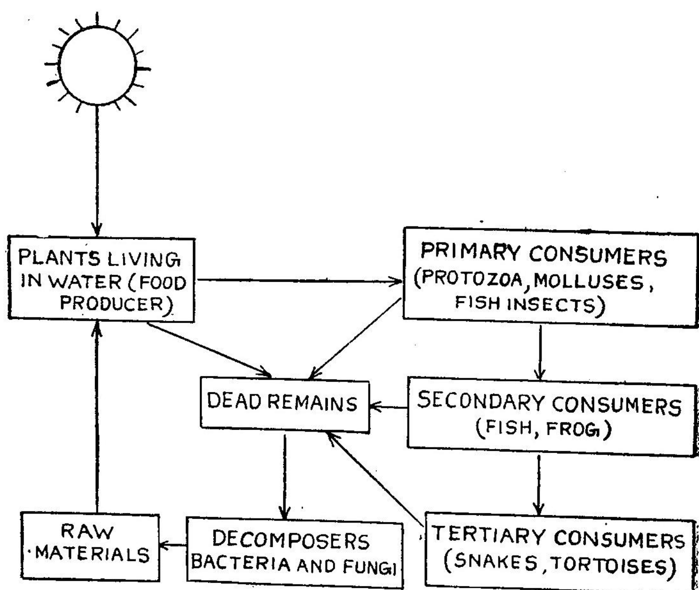


Fig. 145
Food Chain of the living community in water

In this manner the animals and the plants in the tank live harmoniously and are useful to each other. If all the animals and plants

are left out without destruction, their number will increase and it will become uncontrollable. Therefore, their number in the community is controlled. Thus we see the interdependence in the community between the plants and the animals and among animals themselves.

Exercise

I. Questions

1. How do plants in a tank help the living community in a pond?
2. How does a king fisher get its food?
3. How do the fishes get their food?
4. What is the food of the duck? How does it get its food?
5. **Give two examples for each**
   - (i) Water bugs
   - (ii) Water beetles
   - (iii) Fish in tank
   - (iv) Birds near the pond
   - (v) Animals on the bank
   - (vi) Grass varieties that grow in a pond when it becomes dry during summer.

II. For Thought

1. What will happen if the water in a tank dries up?

2. What might happen in a pond community if one kind of organism increased greatly in numbers? Would it make a difference if the expanding population is algae or fish?

6. ANIMALS LIVING IN THE SEA

The sea occupies nearly 71% of the earth's surface. Mineral salts are dissolved in sea water. All living organisms must have originated from the sea. Since the sunlight falls on the upper surface of the sea, the temperature seems to be the same everywhere. As you go deep into the sea, there will be complete darkness. The water in the sea is kept in motion on account of the waves and tides. Moreover, there are water currents. This motion of water helps in the dispersal of food materials. It helps in carrying oxygen to the depth of the sea. Easy movement of animals from one place to another is also possible.

You have studied in lesson 4 that the ponds and tanks would become dry during summer and hence the animals adapt themselves to the conditions by following different methods. The sea water does not dry up. Therefore, the animals living there need not produce cocoons. They need not hibernate during summer.

The sunlight falls directly on the seashores. Hence plants grow well in these areas.

After knowing the environment, let us study how the animals adapt themselves to the conditions found in the sea water.

You would have seen fisherman going in a catamaran into the sea. They bring different types of fishes and other animals living in the sea.

Why should they travel on a catamaran for long distances to catch fishes? You know that the water of the sea, near the seashore is never static and therefore they could not get fishes in this area.

Mammals like **whales** live in deep sea. They are warm blooded animals. Their forelegs are con-



Fig. 146
Whale

verted into fins to enable them to swim in water. Their hind legs are not visible. The tail is used as a rudder to enable the whale to change its course of direction while swimming. Thus the whale is adapted for swimming in sea water.

Mostly **fishes** are found in the deep sea. They differ in size and weight. The size and weight of these fishes are greater than the fresh water fishes. These fishes are similar in their characteristics with those of fresh water fishes. They have fins. They use their gills for respiration. The mouths of these fishes are very big. They keep their body wet always by secreting mucilage. The lateral lines are found on either side of the body of the fishes. Fishes living in the deep sea emit light. With the help of this light, they search for their food. Shark is a kind of fish found in the deep sea.

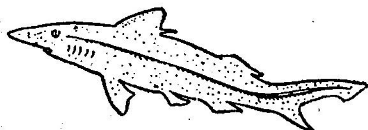


Fig. 147
Shark

On the upper surface of the sea, plants like algae, diatoms etc. and animals like protozoans, molluscans could be seen. Coelentrates like **'physalia'** swim in the water with the help of 'air sacs'. All the animals living in the sea move by swimming. Therefore, their bodies are very light.

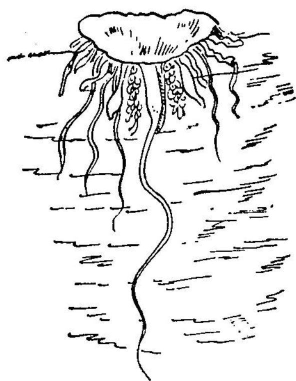


Fig. 148
Physalia

Children are fond of playing on the seashore. They are fond of collecting different types of coloured shells. These shells are nothing but the outer covering of the molluscs living in

the sea water. You can also see sea crabs, snails and coelentrates. The **sea crabs** have flat legs. They use their legs for movement in water as well as on land. They respire through the gill fibres. The gill fibres should be kept wet always. Therefore, they live near the sea water. They are capable of burrowing into the sand. They live in the burrows.

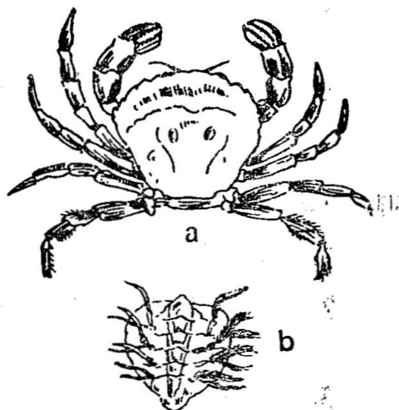


Fig. 149
Crab
a. Dorsal view
b. Gill fibres

Majority of the living beings live only on the upper surface of the sea water. They are green in colour. They produce food with the help of sunlight, carbon-di-oxide and water. Small fishes, molluscs consume the food materials produced by algae and diatoms. The big fishes eat the small fishes. The dead living beings are attacked by bacteria. Thus the living beings in the sea lead a life of harmony and in this manner are useful to each other.

Exercise

I. Questions

1. Why do the animals that live in the sea move easily from place to place?
2. Why do the animals that live in the sea need not produce cocoons?

3. Why do the fishermen travel long distances to catch fishes?

4. How do the whales adapt themselves for swimming in sea water?

5. Name some living beings that live on the upper surface of the sea water.

II. Fill in the blanks

1. Whale is a ——————————

2. Physalia swims with the help of ———— ————————.

3. ———————————— are the outer covering of molluscs.

III. For Thought

1. 'If a fish is taken out of water and placed on land, it dies after sometime' - Why?

2. In what ways are environmental conditions in the sea more stable than those conditions found on the land?

7. MESOPHYTES

Plants absorb the nutrient water from the soil. The nutrient water contains certain mineral salts dissolved in it. Let us understand the properties of the soil which help these plants to grow.

Put some garden soil in a beaker of water. Shake it well. You can see the bigger stones settling at the bottom. Then small stones and sand particles

settle above it. The clay particles settle just above it. Humus floats on the surface of water. Minerals are found dissolved in water.

The amount of water in the soil depends on the climatic conditions like rainfall, heat etc. The temperature of the soil depends very much on the seasonal changes. The temperature is very high in deserts and therefore, the plants do not grow in those places. In polar regions, the temperature is very low and so here also plants do not grow well. The ideal temperature for the growth of the plants ranges from 10°*C* to 45°*C*.

Plants grow well in equitorial regions, because the soil is rich in mineral salts; there will be plenty of humus in the soil; the climate is moderate and the rainfall is sufficient. Those plants which grow in these regions are called **mesophytic plants.**

Beans, mango, jack, hibiscus are examples of mesophytes.

Let us now study the structural adaptations of beans and hibiscus as representative specimens of mesophytes.

1. Bean

Beans, peas, grams, etc. belong to the same family. These plants prepare food rich in protein. A bean plant cannot stand erect. It needs a support to grow. The stem with its branches and leaves

twines round the support. It has compound leaves. A compound leaf has three leaflets. These compound



Fig. 150

a. Bean Plant. *b.* Corolla

1. Standard Petal 2. Wing Petals 3. Keel Petals

leaves are arranged alternately in order to get sunlight.

Flowers are found as **inflorescence.** The calyx consists of five **sepals** which are united to form a cup-like structure. **Corolla is** made up of five petals. The petals are of three types. One is bigger in size and it is called the **standard petal**. The next two are wing like and they are called **wing petals.** The inner two petals are united and are boat shaped. They are called **keel petals.** Within the keel petals, stamens and pistil are present.

Nectar is present surrounding the ovary. When honey bees sit on these flowers to suck the nectar, they bring about pollination. After fertilization, the ovary becomes a dehiscent fruit.

2. Hibiscus

This plant is a medicinal herb. Its flowers are beautiful. The calyx is made of five sepals. The corolla is red. It is funnel shaped. Each corolla is made up of five petals. The filaments of all the stamens are united to form a staminal tube. The style is present inside the staminal tube. It ends in stigma which has five branches. After fertilization, the ovary becomes a fruit. Vegetative reproduction takes place by layering.

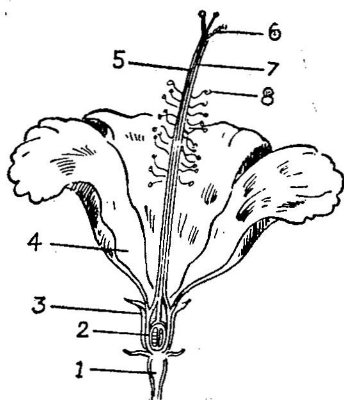


Fig. 151
Hibiscus

1. Stalk
2. Ovary
3. Calyx
4. Corolla
5. Stamen
6. Stigma
7. Style
8. Anther

Exercise

I. Questions

Answer the questions in one or two sentences

1. Give three examples for mesophytic plants.
2. How is the corolla of hibiscus situated?
3. Describe the style of hibiscus flower.
4. Describe the petals of the bean flower.
5. Why does a bean plant need a support to grow?

II. Answer in a paragraph

1. Draw a diagram of hibiscus flower and name the parts.
2. Describe the structure of bean flower.

III. State whether the following statements are right or wrong:

1. Corolla has six petals in a bean flower.
2. Hibiscus is a medicinal herb.
3. Bean is an example for a mesophytic plant.
4. Beans, peas, grams belong to legume family.

IV. For Thought

'Plants grow well in equitorial regions. In polar regions, plants do not grow well' - Why?

8. PLANT COMMUNITY IN THE GARDEN

You have studied how living things in a tank or a pond live harmoniously. Let us study in this lesson how the living beings in the garden are mutually helping one another.

Why should we grow plants in our garden? We can get vegetables; we can also get flowers. Moreover, working in the garden is an exercise to the body. You can get cool fresh air if you have a garden in your house. You will not feel the heat of the sun during mid day.

There are different kinds of gardens. In the **vegetable garden**, brinjal, lady's finger, tomato, chillies are grown by planting seedlings. While planting tomatoes, we should be careful. These plants need



Fig. 152
Vegetable Garden

a shady place to grow. Too much of light will affect their growth. Water should not stagnate around these plants. Greens are rich in mineral contents. Hence they are grown in our garden.

In some gardens bottle gourd, bitter gourd and snake gourd are also grown. We can grow coriandar also in the garden. This plant is used for medicine and for giving flavour to food.

Some people grow trees like mango, cocoanut, margosa, guava, drumstick and plantain.

Certain houses have **flower gardens** in front of their houses. Small plants and creepers like

balsam, blue bells are grown for flowers. If we grow plants like rose, jasmine etc., we can get

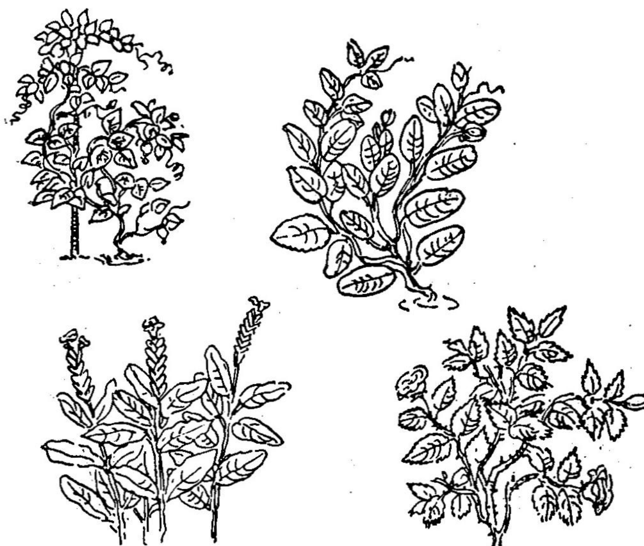


Fig. 153
Flower Plants

flowers daily. Medicinal herbs like omavalli, holy basils are also grown in our gardens.

While growing plants in our garden, we should bear in mind certain points. If the same plants are grown in the garden over and over again, the soil will lose its fertility. Therefore, plants belonging to the bean family should be grown. This method of changing the crop is known as "crop rotation".

Why should the plants belonging to the bean family be grown? Pluck a bean plant growing in your garden slowly without damaging its roots.

Observe the roots carefully. You will find small spherical stuctures here and there. They are called **root nodules.** Inside these root nodules are found

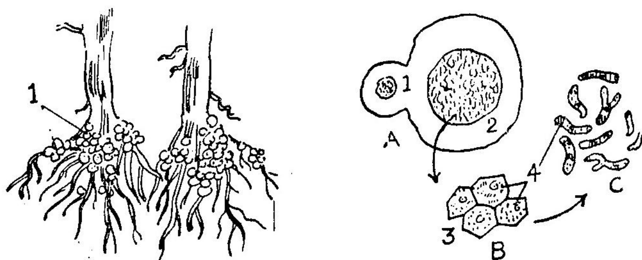


Fig. 154

Root Nodule

A. Cross Section of Root and Root Nodule

B. Cross Section to show Bacteria in the Nodule

C. Bacteria magnified in a microscope

1. Root nodule
2. Cells in the nodule
3. Root
4. Bacteria

certain types of bacteria. They live on the food prepared by these plants. These bacteria are capable of fixing nitrogen of the atmosphere as nitrate salts in the soil. Therefore, plants produce proteins and store them in the seeds.

Exercise

I. Questions

Answer in one or two sentences

1. Why should we grow plants in our garden?
2. Give two examples for vegetables.
3. How is brinjal grown in vegetable gardens?

4. Give the names of two greens grown in the vegetable garden.

5. Write the names of four flowering plants.

6. What do you mean by "rotation of crops"?

7. What are root-nodules? How are root nodules helpful to the plants?

II. Fill in the blanks

1. ————— will affect the growth of tomato.

2. ——— ————— trees are grown in houses.

3. ————— are found in root nodules.

9. ANIMAL COMMUNITY IN THE GARDEN

A garden with plenty of plants is a nice place for animals to live in. Snails, caterpillars, grass-hoppers are found in large numbers in the garden. Garden snakes, lizards and squirrels also live there. The chameleons and green snakes hide them-selves in the green parts of the plants. Rats live in the holes in the garden: birds like parrots and crows come to the garden.

There should be a well or a tank in the garden to supply water to the plants. Mosquitoes and frogs lay their eggs in the water. Leeches, dragon flies and fishes live in large numbers.

In general, the animals living with the plant community can be divided into two groups namely

the animals that help the plant community and the animals that harm the plant community.

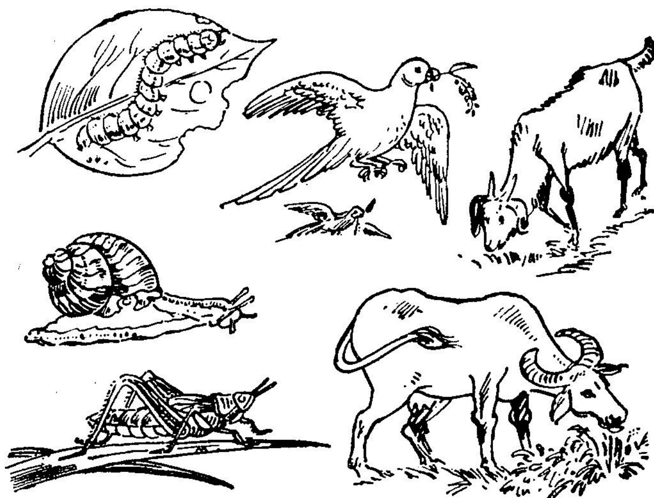


Fig. 155
Animal Community in the Garden

Insects like bees and butterflies are helpful to the plants in bringing about cross-pollination. In this respect, they help the plant community. On the other hand, insects like grasshop-per, caterpillar, etc., cut the tender leaves of the plants and thereby prevent the proper growth of the plants. Therefore, these animals are called the enemies of the plants.

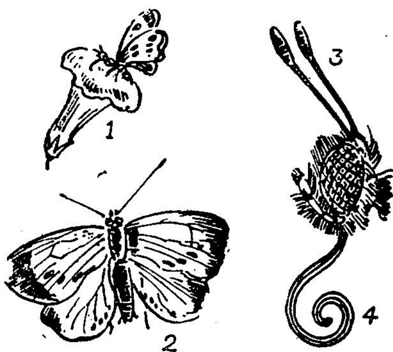


Fig. 156
Butterfly sucking nectar

I. Animals that help the Plant Community

1. Earthworm

Have you seen the earthworms coming out from the soil after heavy rain? Why should they come out during rainy seasons? They come out because the holes are filled with water.

The earthworm feeds on the humus which is mixed with soil. It swallows the soil along with the humus; when the soil passes through the alimentary canal, the nutrient material is absorbed and the remaining waste is sent out through the anus This excreta is called **worm cast** which serves as good manure to the plants. **Charles Darwin** has estimated that the earthworms living in an hectare of land are capable of producing 40 metric tons of worm casts in a year.

A gardener ploughs the land to make the soil soft. The earthworm does the work of the gardener. The earthworm is always burrowing the soil. Therefore, the hard soil is made loose. Hence free flow of air is made possible; In this respect, the earthworms help the farmer. Therefore, earthworms are described as "the friend of the farmer".

2. Insects

Generally, insects are found whirling round the flowers. Honey bees, butterflies, etc., are some of the insects entering into the flowers to suck nectar. How they are helpful to the plant community is described in lesson 10.

II. Animals that are harmful to the Plant Community

1. Snails

Snails are usually seen in paddy fields and meadows. They feed on the tender leaves of the plants. The snail possesses a saw-like tongue; this helps the snail to cut the tender leaves of the plants.

2. Caterpillar

This is the second stage in the life cycle of a butterfly. The jaws are helpful to the caterpillar to cut the leaves into small pieces. When caterpillars are found in the fields, the farmers use D.D.T. to destroy them.

3. Grasshoppers

Usually grasshoppers are found in groups in the grass fields. They are also capable of cutting the tender leaves. Therefore, they are destroyed by using insecticides.

Exercise

I. Questions

Answer in one or two sentences

1. Write the names of the animals that live in the garden.
2. Write the names of the animals that are harmful to the plants.
3. Write the names of the animals that are beneficial to the plants.

II. Fill in the blanks

1. Butterfly sucks nectar by means of its ———————————.

2. The bees feed on ————— ————— —————.

10. INTERDEPENDENCE OF LIFE IN THE GARDEN

You have already learnt about the plants and animals that live in the garden. They live as a community by depending upon each other. No living beings in this world can live independently.

For living in this world, animals and plants need food. The big trees, small trees, small plants, creepers and grasses prepare food in the presence of sunlight by mixing carbon-di-oxide and water. The food prepared by these plants are stored in their parts like roots, stems, leaves, fruits, seeds, etc. Animals such as grasshoppers, snails and caterpillars eat the food prepared by these plants.

In the garden, we see the caterpillar eating the leaves of drumstick. We can also see the grasshopper eating the leaves of beans. These animals are harmful to the plants because they cut the tender leaves of the plants.

The **squirrels, parrots, crows** etc., eat the fruits and nuts. They help the plants in the dispersal of seeds. The excreta of the birds are useful as manure to the plants. The rats live in the holes

in the garden. If the number of rats is allowed to increase in the garden, crops will be damaged because the rats will destroy the vegetables. The snakes catch the rats and eat them. Therefore, the number of rats is controlled.



Fig. 157
Squirrel

Water will be stagnant in the tank found in the garden. Mosquitoes and frogs lay their eggs in this. These eggs are eaten by the animals living in water. Therefore, their number is controlled.

Blood sucker, insects, dragonflies, frogs and and other animals live in the garden. Chameleon

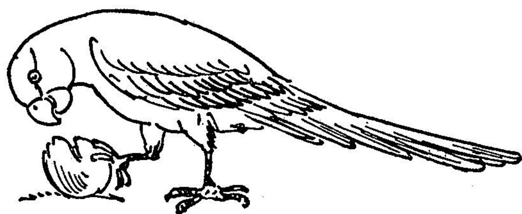


Fig. 158
Parrot

and the birds destroy the insects which do harm to the plants. If the number of insects is reduced, many animals will die of starvation. Chameleon is killed by the cat for food.

If the birds are caught for their feathers and also for food, the insects in the garden will increase in number and damages will be caused to the garden. If the snakes are caught for their skin, the number of rats in the garden will increase and therefore, there will be damage of crops.

Look at the flowers in bloom in your garden. Have you seen the insects flying round the flowesr and sitting on them? Why should they come to the flowers?

Honey bees, beetles, butterflies are some of the insects commonly found entering into the flowers to suck nectar.

Have you ever observed a butterfly sucking nectar from a flower? It has a sucking tube which is coiled like a watch spring. This sucking tube helps the butterfly to suck nectar. Why should the sucking tube be so long? Generally the flowers have glands that secrete nectar at the bottom. The butterfly has to extend-the sucking tube where the nectar is found before it sucks the nectar.

Have you come across a honey bee entering into a pumpkin flower? You might have seen the honey bee coming out of the flower with pollen grains all over its body. When the same honey bee visits another flower of the same plant or another flower of the same kind, the pollen grains fall into stigma of that flower and thus effect cross pollination. Thus the insect helps the plant.

What difference do you find between a butterfly and a honey bee? The honey bee has a sucking tube but it does not coil it as a butterfly. The honey and the pollen found in the flowers are the food of the honey bees. It does not have the long wings like the butterfly.

Thus we find an interdependence in the community between the plants and insects.

When these plants and animals die and reach the soil, the fungi and the bacteria decompose them and release carbon-di-oxide, water, mineral salts,

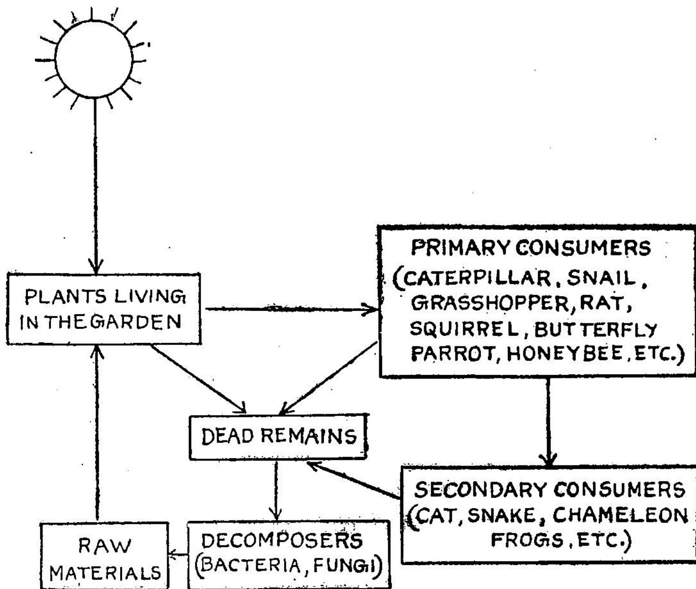


Fig. 159
Food web of living Community in the garden

etc. and give them back to the habitat and therefore, the soil is enriched.

In nature, we find the plants which produce food are enormous in number. The primary consumers are less in number; the secondary consumers are still less in number. Therefore, a balance of life is maintained. These animals and plants live harmoniously and in this manner are useful to each other. If all the living beings are left out without destruction, their number will increase and they will become uncontrolled. Therefore, their number in the community is controlled. We also see the interdependence in the community between the plants and the animals and among animals themselves.

Exercise

I. Questions

Answer in one or two sentences

1. What is "balance of life"?
2. Why should we not destroy all snakes that live in the garden?

11. IMPORTANCE OF FORESTS

Have you ever been to Nilgris during summer vacation? Have you seen the forests of Nilgris? If so, what animals and plants have you seen there?

The teak wood trees, eucalyptus, bamboo trees and sandalwood trees grow in the forests of Nilgris. You can also see small plants, creepers and shrubs everywhere. The temperature is moderate and the rainfall is heavy. Therefore, the plants

are dense and evergreen. On the highways from Mysore to Nilgris, the whole area is covered with green vegetation. In these forests, you can see different types of animals and birds.

How are these forests useful to human beings?

Forests are useful to us in many ways. Timber and firewood are useful forest products. The most valuable timber are teak, pine, oak, sandalwood, rosewood etc. The poorer kinds are used as fuel. Bamboo is the raw material for making paper. Baskets, walking sticks, furnitures and umbrella handles are made with cane. Soft wood is used in the match factory.

Various tanning materials are obtained from the nuts of myrabolan. We get gums and resins, honey wax and honey, rubber and latex, vegetables and oil seeds, medicines from plants growing in the forest. The well known oils are sandalwood oil, eucalyptus oil and turpentine oil. Oils are used in the manufacture of soaps, perfumes, cosmetics and syrups.

Animals and birds living in the forests are also useful to human beings. The tusks of the elephant, the skins of the deer, tiger and leopard, horns of deer are valuable animal products. Blue metals and lime are the mineral products. Thus the forests are useful to mankind in many ways directly.

We always think of the products that are useful and got directly. Therefore, we give them much

importance. Indirectly forests are also helpful to human beings.

The vegetation in the forest contributes to the rainfall in the area. To cut the trees thoughtlessly is to decrease the rainfall that we get. Forests protect the villages from hot and cold winds.

Forests force the rain water to soak into the ground. The shedded leaves in the forest cover the ground and decay. Therefore the water in the ground does not evaporate. The decayed leaves have the property of retaining water. Under the circumstances, the rain water falling on the decayed leaves is prevented from evaporation during summer.

In the forests the trees are so dense that the rain water is prevented from falling on the ground directly. The decayed leaves cover the ground. As the rain water falls on the decayed leaves drop by drop, the soil erosion is prevented.

Let us study how the forests are suitable for the animals and the plants.

Exercise

I. Questions

1. Name the trees that you see in the forest of Nilgris.
2. Why are the plants that grow in the forest of Nilgris ever green and dense?
3. How are the plant products of the forest useful to human beings?

4. How are animal products useful to human beings?

5. Name a few oils that are obtained from the trees of the forests.

II. Write a paragraph on each of the following:

1. How do the trees in the forest prevent soil erosion?

2. How are forests useful to mankind?

III. Fill in the blanks with suitable words

1. ______________________________ is useful for making paper.

2. ______________________________ trees are useful for making matches.

12. THE LIVING COMMUNITY IN THE FOREST

A forest is an uncultivated and uninhabitated land. Forests are composed of trees, growing sufficiently close together. The development of forests is conditioned by a number of climatic factors such as temperature, rainfall, moisture and the presence of sufficient space.

There are four types of forests viz. 1. **Tropical rain forests** 2. **Deciduous forests** 3. **Coniferous forests** and 4. **Temperate forests.**

1. Tropical Rain Forests

These forests occur near the equator. South America, Central Africa, South India, Malaya are some of the areas in which these forests could be seen. Both temperature and moisture are high and constant. The annual rainfall exceeds 200 cm. to 225 cm. Many types of plants are seen. A square mile may contain 300 different types of trees. Under the tall trees, one can witness a continous evergreen carpet.

The leaves are of moderate size, leathery and dark green. Worms, snails, millipedes, centipedes,



Fig. 160
Chameleon

scorpions, chameleons, snakes, ant-eaters, flying squirrels, monkeys, leopards, birds like woodpecker, parrots, humming birds, peacocks are found in this area. In Africa, Tsetse flies are found in the Congo region. In the foot hills of the forest zone of Peninsular India, there are tigers, elephants, deers etc.

2. Deciduous Forests

The trees of this forest shed their leaves in autumn and obtain new leaves after winter. This is an adapt-

ation to suit the conditions of summer and winter. The presence of broad leaves during summer helps



Fig. 161
Animal Community in Tropical Rain Forest

the trees to prepare starch. On the other hand. during winter, the trees become dormant. These forests are found in North America, Europe, Eastern Asia and Japan. The annual rainfall will be 75 cm. to 150 cm. and the temperature will be 10°*C* to 20°*C*.

The trees are quite tall; they are 40 to 50 m. in height. The leaves are thin and broad. Beech, oak, cotton wood, sycamore, elm and willow, teak, sandal-



Fig. 162
Animal Community in Tropical Rain Forest

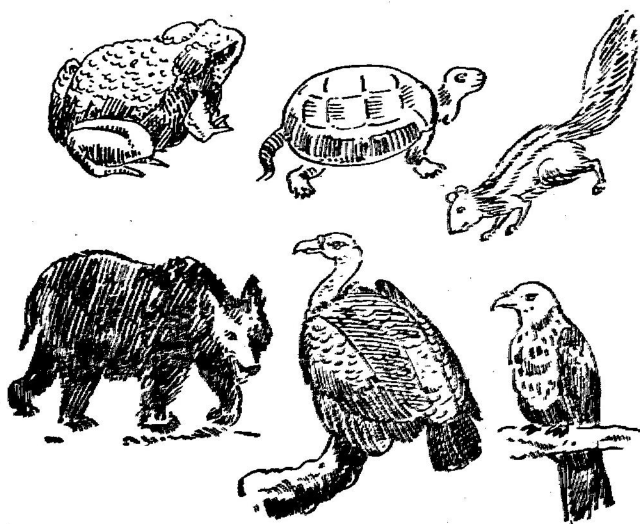


Fig. 163
Animal Community in Deciduous Forests

wood trees are quite predominant. White pine, hemlock, red cedar are also seen. Mosses, algae, lichens grow on the tree trunks. The herbs and shrubs are diversified and well developed. Earthworms, snails, millipedes, salamanders, timber rattle snakes, toads, turtles, lizards, deer, black bears, squirrels, grey foxes, and birds like woodpecker, horned owl, hawk are found here. All these animals show a profound seasonality. Some may hibernate throughout winter.

3. Coniferous forests

Cold regions with high rainfall, strongly seasonal climate with long winters and short summers are characterised by coniferous forests. For example, near the Tundra region is the northern coniferous forests. They are found in North America and Eurasia just south of Tundra. (Canada, Sweden, Finland, Siberia)

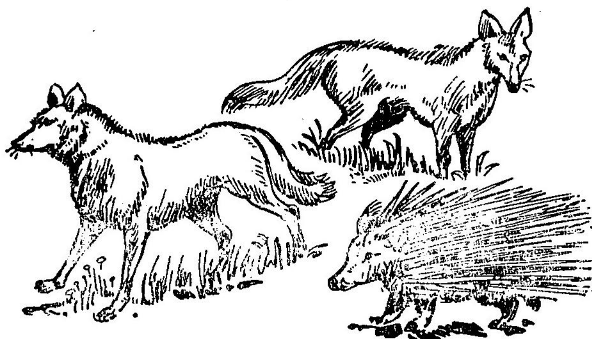


Fig. 164
Animal Community in Coniferous Forests

This is characterised by evergreen plant species, such as spruce and pine trees. Evergreen coniferous

trees retain their leaves throughout the year; the old leaves alone fall at all seasons.

The animals such as wolves, grizzly bears, red-foxes porcupines, squirrels, frogs are represented in these forests.

Soil is not rich. It is because of the movement of the large amount of water through the soil.

There is an important difference between deciduous and coniferous forests in the nature of decaying dead leaves that fall from the trees. Decay of broad leaves is rapid. Needle leaves decompose slowly.

4. (a) Temperate evergreen woodland

Many parts of the world have a mediterranean type climate with warm dry summers and cool moist winters. California in North America, Central Chile in South America, Cape town in Africa, Tasmania in South of Australia are some of the important areas where these types of climate could be seen. Plants which produce fruits are found in these areas. Rabbits, woodrats. lizards, small hooved ungulates are common. Jumping and fast moving animals are common.

(b) Temperate rain forests

The forest is seasonal. Rainfall is high. Fog may also be heavy. Fog is more important as a source of water than rainfall. Eucalyptus, red wood are dominant trees. They will reach more than 100 m. in height. Epiphytes are common.

In South India, forests are found in Mysore, Anaimalai and Courtralam. In Anamalai forests, plants like crotans, itnocarpous, xanthophylla grow well.

In the green forests of Courtralam, short shrubs are found.

Sandalwood trees grow in the forests of Mysore. They grow to a height of 60 feet. 60 to 80 inches of rainfall is essential for the growth of these trees. But sandalwood forests are not dense. Bamboo grows in these forests.

In Maruthamalai, medicinal herbs grow.

Let us now analyse how the forest environment helps the plants to adapt themselves for their growth.

A mature tree is generally much taller than plants that are not so woody. Its height is an adaptation to obtain sunlight. The smaller plants that grow in the shade on the forest floor are of two kinds. Some are shade tolerant plants. They can grow in dim light. The second group comprises of young trees. The young trees begin their growth but most of them die soon because they do not get enough sunlight.

The sunlight is prevented from falling directly on the soil. The moisture content of the soil is more or less stable. The transpiration that normally takes place through the leaves is not carried below the forest canopy due to the absence of winds.

The temperature is generally lower in summer and higher in winter than the surrounding areas. This is because of the presence of thick vegetation. It will be interesting to note that the forests are cooler in day time and warmer at the nights than the surroundings.

Exercise

I. Questions

Short Answer Type

1. What is a 'forest'?
2. What are the factors responsible for the development of the forests?
3. Name the different types of the forests.
4. List down the different types of plants found in tropical rain forests.
5. State a few animals that live in tropical rain forests.
6. 'The trees of deciduous forests shed their leaves in autumn and obtain new leaves after winter' - Explain this with reference to the adaptation of plants in these forests.
7. Describe the quality of trees grown in deciduous forests.
8. Give the names of four trees that grow in the deciduous forests.
9. Name the plants that grow on the trunks of the trees.

10. Name a few animals that adapt themselves to the environment of deciduous forests.

11. Where do we find coniferous forests? State a few trees that live in coniferous forests.

12. State a few species of animals that represent coniferous forest.

13. Write down the names of two trees that grow in the places where rainfall and fog are found to be sources of water.

14. Name the trees which grow in the forests of Mysore.

15. 'The moisture content of the soil is more or less stable' - Explain this statement with reference to the sunlight and forest canopy.

II. Essay Type

1. Bring out the differences between deciduous and coniferous forests with special reference to climatic conditions, the fertility of the soil and the nature of leaves.

2. Describe the adaptations of plants in the forests.

III. For Thought

'The forests are cooler in day time and warmer at the night than the surroundings' - Analyse this statement.

13. ANIMALS LIVING IN THE FOREST

Most of the animals living in the forests have the capacity to climb up the trees. Lizards, birds, and mammals live on the trees. In the rivers flowing

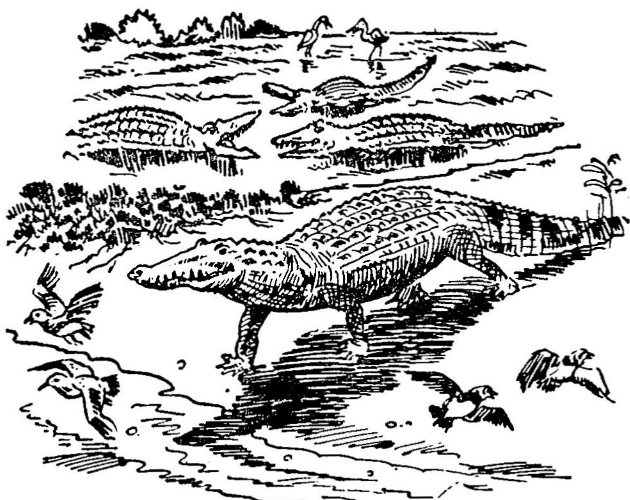


Fig. 165
Crocodiles

through the forests, animals like crocodiles, snakes etc., live. The animals that live in the water become their food.

On the branches of the thickly grown trees, you can see **pythons** and other dangerous snakes, coiling and hanging upside down. Unless they move, they cannot be detected.

Although there are lizards on the barks of the trees, they cannot be easily seen because the colour

of the lizards resembles the colour of the environment.



Fig. 166
Python

Chameleon is a kind of lizard. It is capable of changing its colour according to the environment in order to protect itself from its enemies. Chameleon lives by eating the insects. Its big toe is modified to grasp the tree and its tail can coil itself spirally around the branches of the trees.

Several kinds of birds like owls, eagles, vultures, pigeons, peacocks, parrots and wood peckers live in the forest. They build their nests on the trees. Rats and rabbits burrow holes and live in hiding.

Further, squirrels and monkeys jump and play on the branches of trees. Bats hang upside down on the branches. The forelimb of the monkeys

are slightly longer than their hind limbs. It is to facilitate easy swinging on the branches of the trees.



Fig. 167
Monkeys

Among the invertebrates, the worms, snails, millipedes, centipedes, scorpions, spiders, insects such as bugs, beetles etc. live beneath the barks of the trees or in the crevices of the decaying wood. Leeches are found in bushes.

In the forest, you can find herbivores like elephants, deer, bison, hares, carnivores like bear, fox, lion, tiger, leopard, ant-eaters and omnivores, like wildpig, crows etc.

Animals living in the forest show many adaptations to forest life. The acquatic animals are surrounded by water; they do not experience scarcity of water. Their bodies will not become dry. But the conditions that prevail on the land are different. The animals are surrounded by air; the temperature

fluctuations are greater; the problem of water conservation becomes very acute. Therefore, to prevent

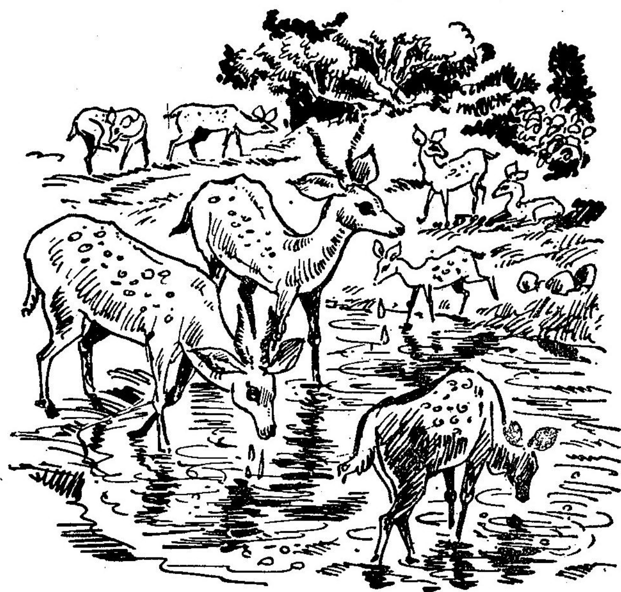


Fig. 168
Deers

the body of the animals getting dry easily, they have a thick skin. Therefore, they are strong and muscular. In the same manner, the eggs are protected by hard shells.

The development of the capacity to live on trees is a very important feature of animals that live in the forest. Such animals are characterised by the presence of sharp claws.

The development of an opposite toe is another feature, common among animals living on trees. Examples are chameleons, wood-peckers, monkeys.

Sucking discs on the feet is another common adaptation to ensure smooth climbing among forest animals. Eg. lizard.



Fig. 169
Bison

The thick growth of the forest vegetation restricts the easy movement of animals. Therefore, special adaptations such as wedge shaped head, short limbs, strength and weight are developed in the mammals. The horns which are a hindrance to movement are reduced in the forest mammals.

Thus the animals in the forest adapt themselves to the environment in which they live.

Let us study some of the important animals that live in the forests of India in lesson 15.

Exercise

I. Questions

Give answers in one or two sentences

1. The lizards living on the barks of trees are not seen easily - Give reason.

2. How is chameleon capable of protecting itself from its enemies?

3. What adaptation does a monkey possess in jumping from one branch to another branch of a tree?

4. Name some animals which live on fruits and vegetables.

5. Name a few herbivores living in the forest.

6. Name a few carnivores living in the forest.

II Write the answers in a paragraph

Write about 15 lines how the animals in the forest adapt themselves according to the environment in which they live.

III Fill in the blanks

1. ———————— ———————— burrow holes and live in hiding.

2. Sucking discs on the feet is an adaptation in animals like ————————.

IV. For Thought

The adaptations of animals that live in water differ from those of animals that live on land. Explain.

14. INTERDEPENDENCE OF LIVING COMMUNITY IN THE FOREST

You have already learnt about the plants and animals that live in the forests. They live in a com

munity by depending upon each other. No living being in this world can live independently.

For living in this world, animals and plants need food. The big trees, small trees, small plants, creepers, and grasses prepare food in the presence of sunlight by mixing carbon-di-oxide and water. The food prepared by these plants are stored in the parts



Fig. 170

a. Interdependence of Animals in the Forests

like roots, stem, leaves, fruits, seeds etc. Animals such as insects, deer, bison, hares, rabbits eat the food prepared by these plants. This we call the **primary consumers (Herbivores).** Tigers and cheetah, which take rest in the shrubs, live by eating the rabbits, and the deer. Chameleon may eat the grasshopper and the insects. A snake may eat

a mouse. A vulture or a mangoose may eat a snake. These **carnivorous** animals are called **secondary consumers.**

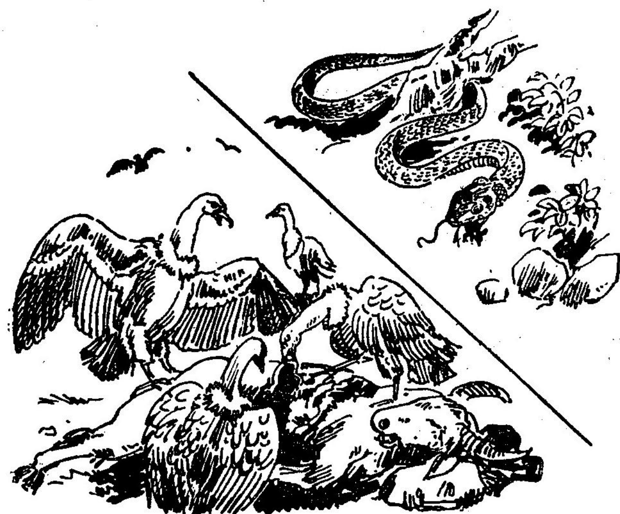


Fig. 171

b. Interdependence of Animals in the Forests

If the green vegetation in the forest grows well, the rabbits, hare, deer and other herbivorous animals will increase in number. The tiger, the cheetah etc., kill them for their food. Therefore, the number of these animals in kept under control.

If the growth of the green vegetation in the forest is meagre, the deer and the rabbits will come to the paddy fields to destroy the crops. If the number of rabbits and deer is reduced in the forest, the tiger or the cheetah will enter the areas where human beings are living and destroy the sheep or the cows.

The birds living in the forest are also adapted to their feeding habits. **Woodpecker** is a common bird living in the forest. It has a long beak which is chisel like. It eats the insects found inside the trunk of the trees. The woodpecker with its beak will form a hole in the trunk and catch the insects by means of its tongue. Thus the woodpecker is helpful in the growth of the plants.

Parrot lives on fruits and nuts. Its beaks are adapted for cracking the nuts.

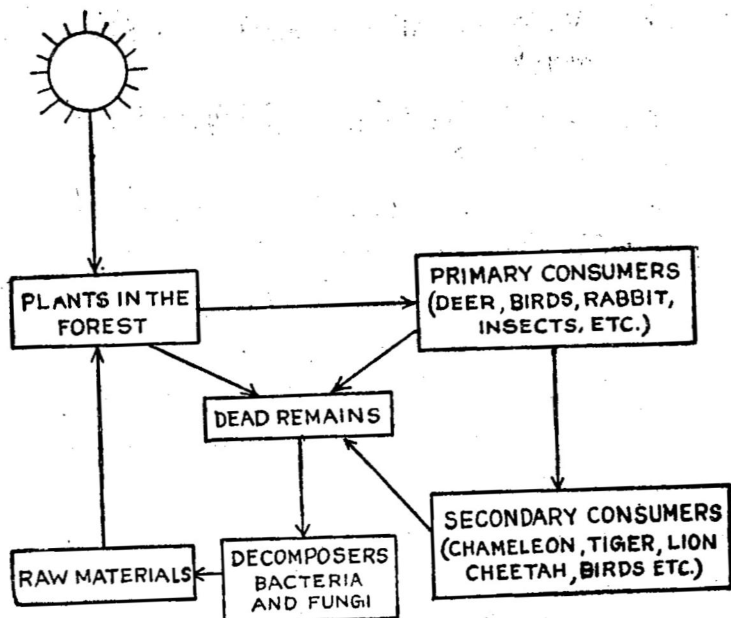
Its legs are strong and its claws are pointed. When this bird goes round and round in the air and when it comes across a snake or a rat, or a frog, it dives immediately and takes it to a distant place to eat it. Its beaks are adapted for carnivorous habit.

When these animals and plants die and reach the soil, fungi and bacteria decompose them and release carbon-di oxide, water and mineral salts and give them back to the habitat and therefore the soil is enriched.

In nature, we find plants which produce food are enormous in number; the animals that eat them are less in number. The number of animals that destroy the primary consumers are still less in number. Therefore, a balance of life is maintained.

The animals and plants living in the forest live harmoniously and in this manner are useful to each other. If all the living beings are left out without destruction, their number will increase and they will become

uncontrolable. Therefore, their number in the community is controlled. Thus we also see the interdepen-



Fig, 172

Food-web of Living Community in the Forests

dence in the community between the plants and animals and among themselves.

Exercise

I. Questions

Give answers in one or two sentences

1. What are the raw materials needed for the plants to prepare food?

2. Name the parts of the plants where the food is stored.

3. Which animals are called primary consumers? Why are they called so?

4. Which animals are called secondary consumers?

5. How is the balance of life maintained in the forest?

6. What will happen if the number of rabbits and deer is reduced in the forrest?

7. Describe how the woodpecker gets its food from the trunk of the trees.

8. What is the food of the parrot? Describe how its beaks are adapted to its feeding habits.

II. Write the answers in a paragraph

1. How does the soil in the forest get enriched?

2. How are the birds living in the forest adapted to their feeding habits? Explain with examples.

III. Fill in the blanks

1 Primary consumers are called ————.

2. ———— are called secondary consumers.

3. The beaks of vultures are adapted for ——— habit.

IV. For Thought

Animals and plant on land, compared to the animals and plants in water, face more number of problems. Explain why.

15. INDIAN WILD LIFE

Go on an excursion to the zoo to know about the strange features of the wild animals. You will be interested to see a tiger or a lion in cage; you will also be interested to see the giraffe eating the leaves from the trees with its long neck. If all these animals are seen in their habitat, how beautiful and interesting it would be!

Wild animals are found in different parts of India. People usually think that the elephant is the strongest animal; and that the rhinoceros attacks its enemies with its horns; the snakes are capable of hearing the sound of the snake-charmer. All these statements are not scientifically correct. If we observe them closely, we can understand them properly. Let us now study about a few Indian wild animals in detail.

1. Elephant

Among the wild animals, the elephant is a strange creature. Elephants are found mostly in India. They live in groups in the forests of Karnataka, Kerala and Tamil Nadu States.

The elephant is different from other animals in its appearance. The nose is modified into a long

trunk. There are two holes in the trunk. The elephant is able to lift and drag heavy wood using the trunks.

Another important structure is its tusk. The male elephant has two tusks, whereas the female elephant does not have them. Its legs are long and stout. The feet are so soft that it can not withstand the heat of the road during midday. Its ears are broad. It moves them always. This movement helps it to prevent worms and insects from entering into the ears.

What difference do you find between an Indian elephant and an African elephant?

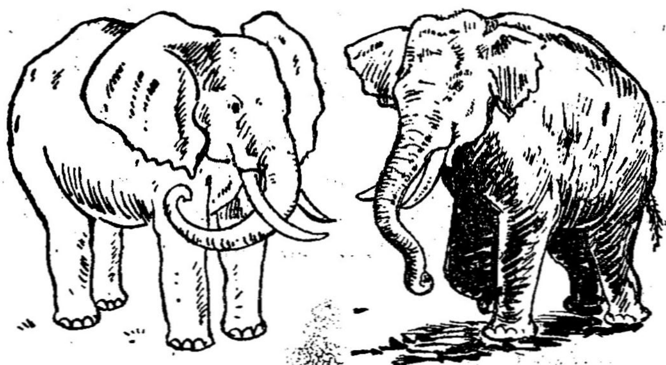


Fig. 173

1. African Elephant 2. Indian Elephant

In India, the male elephant alone has tusks. But, the elephants of Africa (both male and female) have tusks. These tusks are very long and thick when compared to that of Indian elephants. The

skin, the tusks and the bones of the elephants are useful to prepare many valuable ornaments.

2. Tiger

Tigers are found in large numbers in forests of West Bengal, Bihar and Uttar Pradesh. They lead an independent life. It sleeps in day time and goes in search of food at night. Its eyes shine very bright



Fig. 174
Tiger

like balls of fire. Its ears are sensitive. The nails found on its feet are pointed and sharp. It is capable of climbing up the trees. It feeds on small animals like frog, fish, and big animals like cattle. It attacks the cattle from the back and kills them. It even kills man and sucks his blood.

A tigeress gives birth to three cubs at a time. It hides the cubs in shrubs and teaches them how to catch the prey. Men hunt the tigers for their skin. The skin is yellow and has stripes.

3. Rhinoceros

Rhinoceros is found in the forest of Assam. It is smaller in size than the elephant but it is the only animal which can fight with the elephant.

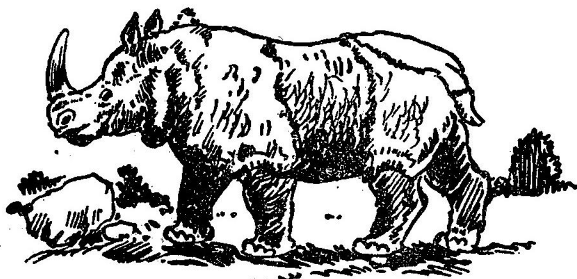


Fig. 175

Rhinoceros

Its skin is very thick and so even bullets cannot pierce through it. It has only one horn. In this respect, its appearance is peculiar. This horn is long but it does not use it to attack other animals. Rhinoceros with two horns is very rare.

Its horn has the capacity to reduce the poisonous nature and gives more stength to the body. The skin, muscles and bones are valuable. People wear the bone of rhinoceros thinking that it will cure any diseases.

4. Snakes

Among the reptiles, the snake is a wonderful creature. It has no legs: but it moves very fast.

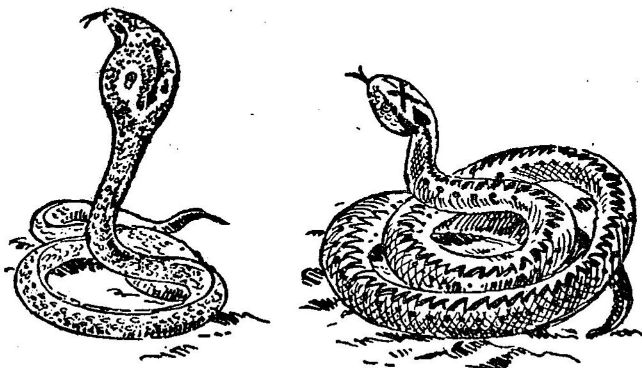


Fig. 176
Poisonous Snakes
1. Cobra 2. Krait

Some snakes are capable of swimming and some are



Fig. 177
Non poisonous Snake
1. Water Snake 2. Green Snake

capable of climbing up the trees Mostly the snakes live in the holes found in the earth.

The tongue of the snake is forked at the tip. In this aspect, its tongue differs from that of other animals. It is sensory in nature.

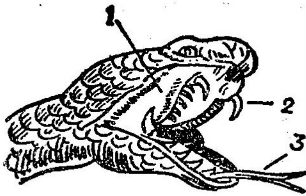


Fig 178.
Mouth Parts of a Poisonous Snake

1. Poisonous pouch
2. Sting
3. Tongue

The snake has two eyes but they have no eye-lashes. It has no external ear and therfore, it is not capable of hearing. But the snake is capable of feeling the vibrations, however feeble the vibrations may be.

Snakes are of two kinds - poisonous and non-poisonous. The viper, krait and cobra are poisonous snakes. The green snake, water snake etc., are non-poisonous. Only poisonous snakes have the sting.

Mostly snakes feed on insects, rats, frogs and fishes.

The skin of the snake is used for making money-purses, belts, shoes, hand sticks etc.

Lions are found in **Gujarat.** Bears are found in the regions of **Himalayas** and **Kashmir.** Musk deer, yak are also found in this area.

In **Cachar mountains,** bonnet monkeys are found in plenty. Stags, cheetah, wild dog are seen in the grassy meadows adjacent to the **Satpura** ranges in

Madhya Pradesh. Wild asses are found in the grassy meadows of **Kutch** in Gujarat.



Fig. 179
Lion

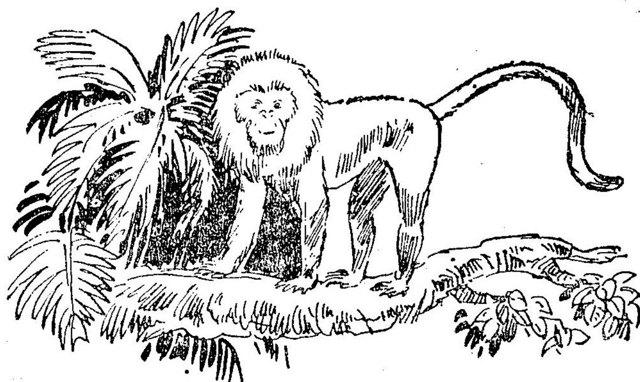


Fig. 180
Bonnet Monkey

From the above paragraphs, it would be clear that the Indian wild life is greater both in numbers and kind. But these animals are dwindling in number and are slowly becoming extinct. They need protection.

Why the animals are dwindling in number and what are the steps taken by the Government of India to protect them is dealt with in lesson 16.

Exercise

I. Questions

Answer the following questions in one or two sentences

1. What are the general views of the people about wild animals?
2. Describe the appearance of an elephant.
3. Enumerate the differences between an African elephant and an Indian elephant.
4. Where do you find tigers in India?
5. What is the main food of a tiger?
6. Describe the appearance of a tiger.
7. The skin of rhinoceros does not allow the bullets to pierce through it. Why?
8. Give the uses of rhinoceros.
9. Describe the tongue of a snake. How is it useful to the snake?
10. Name two poisonous snakes.

II. Fill in the blanks

1. The snakes feed on ——— ——— ——— ———.
2. The snake has two eyes, but they have no ———.
3. The skin of the snake is used for ——— ——— ———.
4. Bonnet Monkeys are found in ——— mountains.
5. Wild asses are found in grassy meadows of ———.
6. A tigress gives birth to ——— cubs at a time.

III. State whether the statements given below are right or wrong:

1. The elephant is the strongest animal.
2. The nose of the elephant is modified into a long trunk.
3. The snake has legs.
4. All snakes have stings.

16. PRESERVATION OF WILD LIFE

It is needless to say that animals and birds add wealth to the forest. The powerful elephant, the fierce tiger, the majestic lion, the nimble deer, the dancing peacock, the beautiful parrot, the singing nightingale are wild animals and birds which our

country can be proud of. It is interesting to watch them in their natural surroundings.

The forests of India are under the control of the Forest Department and constitute an area of little more than 1/10 of the total area of India.

After independence, the Government of India began to devote its attention to the forest department. A board for Wild Life was constituted in 1962. The main function of the board is to protect wild life. 'Protection to Wild Life Act' prevents hunting of wild animals. But man has been carelessly destroying wild life without knowing its great values. He kills them to protect his crops; he kills them to prepare some valuable articles. Therefore, it is important to educate the public to preserve wild life. Man should not be allowed to kill animals as long as they do not harm him.

To give protection to wild animals, wild life sanctuaries have been started. The animal sanctuaries at Mudumalai and Thekkadi and the bird sanctuary at Vedanthangal are famous in South India. Kazirango sanctuary in Assam and Gir forest of Gujarat are famous in North India.

Rhinoceros is preserved with great care by the Kazirango Sanctuary in Assam and the lion in Gir forest of Gujarat.

Let us study about the sanctuaries of Tamil Nadu.

1. Vedanthangal Sanctuary

Vedanthangal lake is situated in Chengalpattu district. There are about more than 500 kadamba

trees in that lake. Thousands of different varieties of birds come to Vedanthangal lake. It is a pleasant sight to look at these birds. These



Fig. 181
Vedanthangal Sanctuary

birds feed on small fishes, snails and insects. Cormorants, egrets, grey herons are some of the birds that come to this lake. They build their nests, reproduce and increase their progeny.

2. Vedaranyam

This sanctuary is called Kodikarai sanctuary. It is situated in Tanjore district. Many kinds of birds come to this place.

3. Mudumalai Sanctuary

This is situated in Nilgris district. It is a beautiful forest with pleasant surroundings. Animals living in this sanctuary play and roam here and

there, of their own accord. The elephants are seen in large numbers as herds. The ant-eater is also seen in this forest. Four horned deer, wild squirrel,

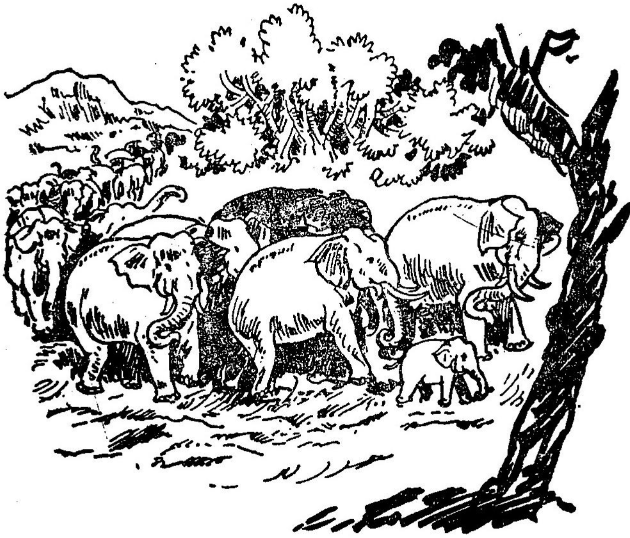


Fig. 182

Mudumalai Sanctuary

bonnet monkey, snakes etc. are found in this sanctuary. The natural roaming of these animals in their habitat is a feast to the eyes.

Why should the animals dwindle when there are sanctuaries? Many reasons may be given. A few of them are summarised below:

1. Due to increase in population, the forest area is much reduced. Men are destroying many forests. So the number of wild animals also decreases.

2. Men are destroying the forest to grow more food and make them a living place.

3. When trees rub against each other in the forest, fire is produced which destroy the forest. In such a natural calamity, some animals also die.

4. Man considers hunting as a pastime. He gets the permission from the Government for hunting. He kills many valuable animals for their skins, bones, tusks, etc.

Thus wild life is destroyed by the people and by natural calamities.

To prevent the dwindling of wild life, the Government is educating the public. The Vanamahotava Day Celebrations and Wild Life Week Celebrations will help the people to realise the importance of forest and wild life. Wild life week is celebrated in the first week of October every year. On that day, we, the citizens of India, take the pledge to do our duty to protect the wild life. The pledge contains the following points:

1. The foundation of human civilisation is natural environment.

2. It is the duty of every citizen to protect this environment.

3. It is also the duty of every citizen to hand over this wealth for the benefit of our posterity.

4. It is the duty of every citizen to protect the increasing wild life.

5. It is the duty of every citizen to preserve the natural environment by increasing its wealth.

Exercise

I. Questions

Give answers in one or two sentences

1. Name a few animals about which our country can be proud of.
2. Why do men kill wild animals?
3. Where do we find animal sanctuaries and bird sanctuaries in India?
4. Name a few animals preserved with great care in North India.
5. Why should the animals dwindle when there are sanctuaries?
6. State the pledge taken by the citizens of India to protect wild life?
7. Name two wild animals preserved in Mudumalai sanctuary.
8. Give the name of a few birds that come to Vedanthangal sanctuary.

II. Give answers in a paragraph

1. Describe the steps taken by the Government of India to protect wild life.

III. Fill in the blanks

1. The main function of the Board of Wild Life is to ——————.

2. ———————— Act prevents men from hunting wild animals.

3. ———————— is preserved by the Kazirango sanctuary in ——— and the lion in ——— forest of ————.

4. Thousands of different varieties of birds come to ———— lake in Chengalpattu district.

5. ———— sanctuary is called Kodikarai sanctuary.

6. Mudumalai sanctuary is situated in ——— district.

17. LIVING COMMUNITY IN THE GRASSLAND

Have you ever seen the cows and buffaloes chewing their food while they are taking rest? Have you ever thought why they do so?

Cows and buffaloes by nature are not adapted for fast running. When they are grazing in the meadows, they always think of their enemies and eat the grass very quickly. The food is stored in the stomach. When they take rest, it is brought to the mouth again for chewing.

Do you find the horses and asses chewing their food in this manner? No. They are not afraid

of their enemies. They are fast runners. They swallow their food only after chewing.

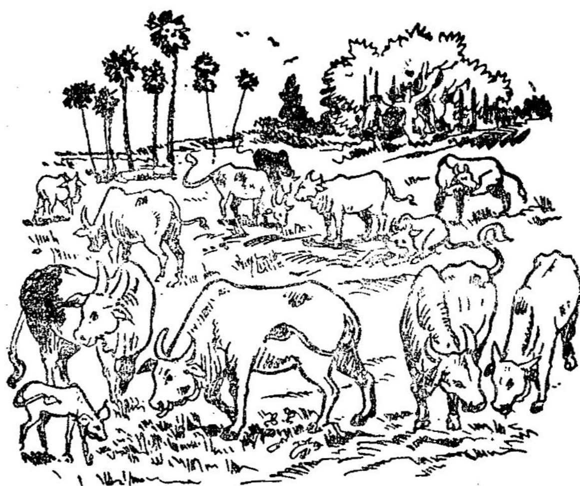


Fig. 183
Living Community in Grass land—Bulls and Cows

Let us study about the adaptations of the living community in the grass land.

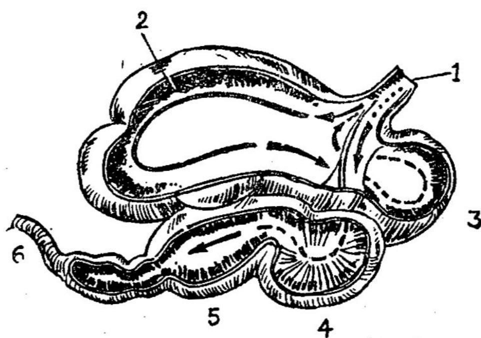


Fig. 184
Structure of a Cow's Stomach

1. Oesophagus 2, 3, 4, 5. Compartments of the Stomach
6. Duodenum

Grassland occurs in almost all continents. They are mostly found close to the forest. Everywhere

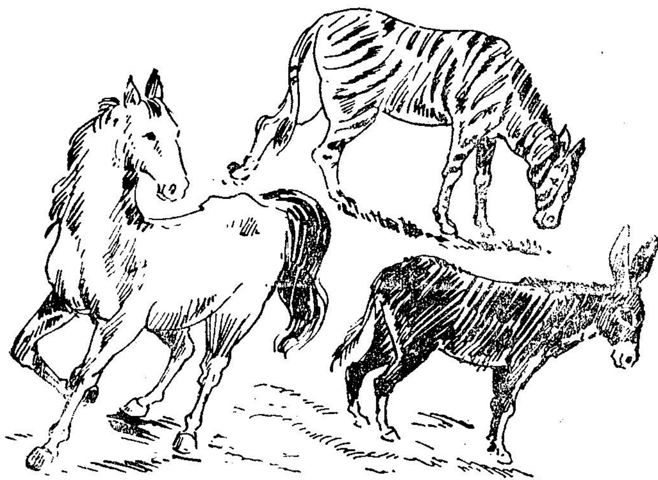


Fig. 185
Living Community in the grass lands—horse, donkey

they possess similarities of climate. The annual rain fall ranges between 60 to 70 cms. The soil is darker in colour and rich in organic matter.

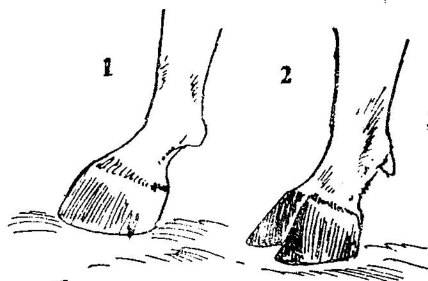


Fig. 186
Hoofs
1. Horse 2. Cow

Grasses grow quickly during rainy season. Grasses may be tall or short but they grow in bunches. The leaves of the grasses die during unfavourable seasons. The underground buds regenerate (new growth) during the next favourable period. Since the grasses grow

from the base of the leaf, they can tolerate considerable grazing by large herbivorous animals. Animals like

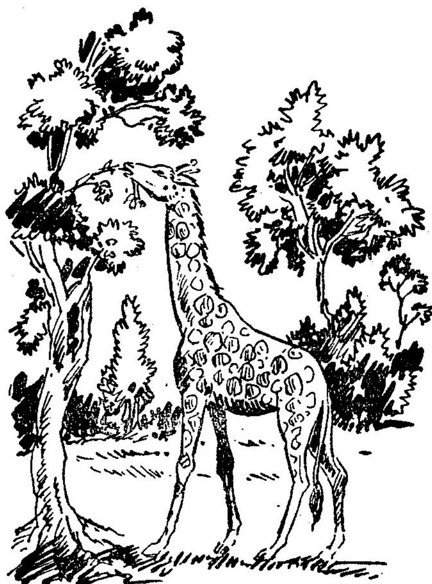


Fig. 187
Giraffe

giraffe, deer, zebra, ass, horse graze in the meadows.

It is common for these animals to feed in large herds. A herd would graze in an area for several days. They move to some other area after some days. In these movements, they generally travel in groups. They are adapted for fast running.

The animals shed their fur in summer. They are greatly annoyed by flies and mosquitoes. They relieve their miseries by rolling in wallows, covering

themselves with mud. They are killed by wolves, lions, tigers, etc., The squirrels, mice, rabbits are common animals found nearly everywhere in the meadows.

The development of hopping movement is of special interest. Rabbits, mice and grasshoppers have

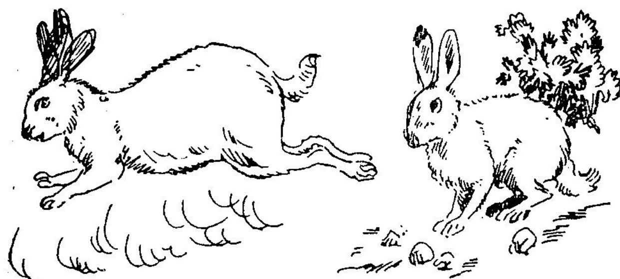


Fig. 188
Rabbits

short forelegs and long and strong hind legs. Hopping enables the animals to get above the level of the grass during movement.

Birds coming to the meadows are capable of flying quickly and can withstand the fierce winds. All the animals are capable of tolerating the direct rays of the sun.

Small birds, grasshoppers and other insects rely considerably on their well developed protective colouration.

Many of the animals become inactive during dry season. They hibernate during that period.

Exercise

I. Questions

1. Why do cows and buffaloes chew their food while they are taking rest?
2. Name the herbivorous animals which do not have 'cud chewing'?
3. What is the name of the animal which has a long neck? Why should that animal have such adaptation?
4. List down atleast three adaptations of animals living in grassland.

13. LIVING COMMUNITY IN DESERT

(A) Plant Community

Have you seen vegetations like cactus and casuarina? Where do they grow? What adaptations do they have to grow in that habitat?

These vegetations grow in arid regions; in these regions the rain fall is meagre. The moisture in the atmosphere is insufficient to support the plants. High temperature is characteristic of this region. High temperature causes an increase in air movements and therefore dust storms are common. The soil is sandy and water can be seen at very great depth below the sandy soil.

The desert plants have shallow roots, extending over a wide area. When rains come, these plants rapidly take up water and store it in specialised tissues.

Cactus stores large amounts of water in their fleshy stems. This water allows the plants to continue to live during long period of drought.

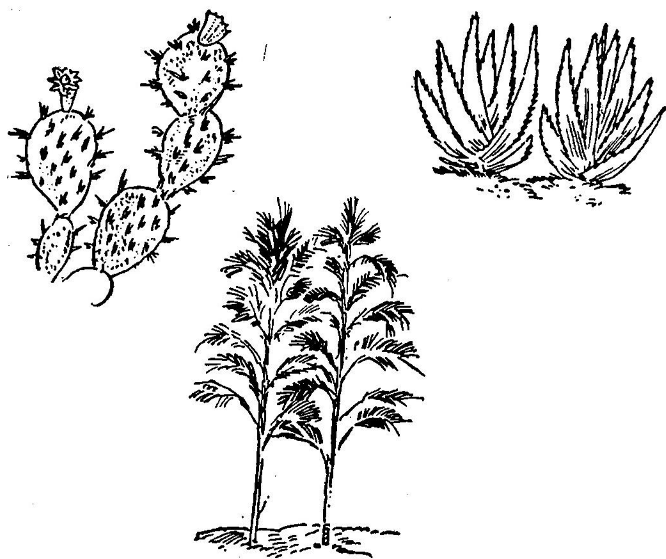


Fig. 189

Plant Community in the Desert

Usually the leaves of the plants are very fleshy containing mucilage. In some other plants, they are reduced in size, to minimise transpiration. In cactus, the leaves are modified into spines. The cuticle is thick on the epidermis to check evaporation of water. Sometimes, multiple epidermis develop as in oleander. Stomata are few in number and remain sunken in grooves. When typical leaves are present on desert plants, they are usually small, thick and leathery.

The plants that grow in the desert places are called **Xerophytes.**

How do these plants prepare food? When the area of the leaves is reduced, will it not affect photosynthesis?

Though the leaves are small, the stem and petiole are thick. They possess chlorophyll. Thus the manufacture of food is made possible.

Cactus

Let us study the structure of cactus (opuntia), as the representative specimen of desert plants.

The roots grow deep into the soil, to absorb water. During rainy season, new lateral roots grow to absorb water from the surface.

The leaves are small. They soon wither away. The leaves are modified into spines. These spines are helpful to protect the plant from enemies. The stems are green and fleshy. They perform the function of the leaves. So it is called **'Phylloclade'**.

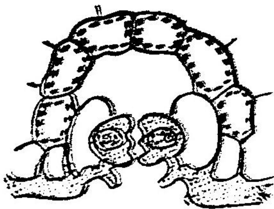


Fig. 190
Compressed Stoma of a Desert Plant

Water is stored in the stems. The whole body of this plant is coated with wax to prevent transpiration.

Casuarina, Bryophyllum, Thirukkalli etc. are some of the Xerophytic plants. Study these plants carefully to know how they adapt themselves to dry conditions of the desert.

(B) Animal Community

Have you seen camels? Where do they live? How are they useful to mankind?



Fig. 191
Camel

Ordinarily camels are found in the deserts. They are useful to travellers to cross the desert. They are found in the Thar desert in India.

You know that the need for water is keenly felt in the deserts. Water holes or springs are seen only in a few places. They are called **oasis**. On the banks of oasis you can find date palms. The travellers take rest in the shades of these trees.

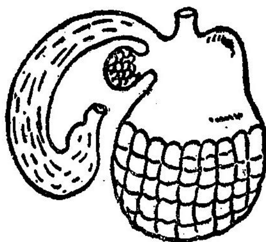


Fig. 192
The Stomach of the Camel - Rumen

You may wonder whether animals could live in dry conditions. Yes, they do. Let us

now study how the animals adapt themselves in such a habitat.

Desert animals are generally active for brief periods during the year when water and food are available. Uromastix stores water in its large intestine. In the camel's rumen, a great deal of water mixed with the food is present in a pocket like structure. People call this pocket as water sacs. It is not correct. Spiny lizards are living in the desert sands of Australia. Their skins are capable of absorbing water just like a blotting paper. Some animals escape from high temperatures by burrowing quickly into the sand. They avoid daylight and go in search of prey only during night. *E.g.* desert mongoose.

Beetles and lizards living in the deserts are capable of withstanding high temperature. The desert cat has wide soles clothed with fur and is capable of running fast in the hot desert sands. The legs of

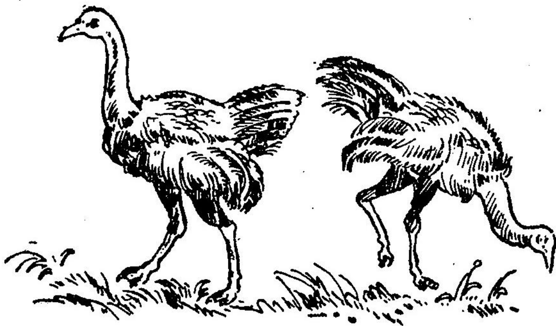


Fig. 193
Ostrich

the desert bird **ostrich** are provided with pads. The legs of the camels are long. Their feet are provided

with broad soft pads. Therefore, they do not sink into the sand while walking.

Have you not read that there will be dust storms during the day time in the desert? Will not the important organs like the eyes, ears and nostrils of the desert animals be affected?

The nose is protected by complicated valves. The nose is reduced to small pinholes. The nose of the camels can be closed just as many animals close their eyes. The eyes of the camel are protected by long eye lashes and the eyes are kept high on the head. The ears are protected by hairs.

Most of the animals have dull colour. Warning colouration is seen among the poisonous lizards like Heloderma. This is the only poisonous lizard in the world. It is seen in the dry regions of Mexico.

Exercise

I. Questions

Answer the following questions in one or two sentences:

1. Write the names of two Xerophytic plants.
2. Where is the food prepared in Xerophytic plants?
3. How is transpiration controlled in Xerophytic plants?

4. 'Majority of the Xerophytic plants possess thorns on the body' - Why?

5. What is the name of the poisonous lizard? Where do we find such lizards?

6. Name the part of the body where a camel stores its food and water.

7. Describe the adaptations of desert lizards.

II. Answer the following in about a paragraph:

1. How is a camel adapted for its living in a desert?

2. Write briefly the adaptations of Xerophytic plants that live in the desert.

III. Fill up the blanks

1. A phylloclade is ——————

2. A camel can be found in —————— sands in India.

3. The name of the bird that lives in arid sands is ——————.

4. The leaves of casurina are modified to —————— to adapt themselves in desert conditions.

19. THE LIVING COMMUNITY IN TUNDRA

If we undertake a journey up the slope of the Himalayan mountains, we may see 'lichens', 'mosses' and small flowering herbs. This is a rugged environment. Therefore, no large plants grow in these places. These plants are usually of 2′ to 4′ in height. Germination of seeds is poor. Most plants require many years to produce first flowering.

Temperatures are very low. Winds are strong Water is available only for a short period. Only for about 60 days in a year, it presents suitable condition for plant growth.

Common animals of the Tundra are caribou, grizzly bear, polar bear, grey wolf, lemming, reindeer, snowy owl etc. Many of these animals get their food from the fresh water ponds. In the ponds, you can come across fish, leeches, snails, beetles etc. Fishes are more numerous in rivers but migration is common. Spiders and mites are well represented. Mostly insects are wingless. Ants are scarce but bumble bees are conspicuous.

White colouration is common. When the ground is covered with snow, white colouration helps the animals to protect themselves from their enemies.

A major habitat problem that these animals must solve is tolerating severe cold. Dense hair growth is found on their bodies. The bear possesses white

hairs like the snow. It avoids summer. Hence it hibernates during summer. After the summer period, it starts a busy life.

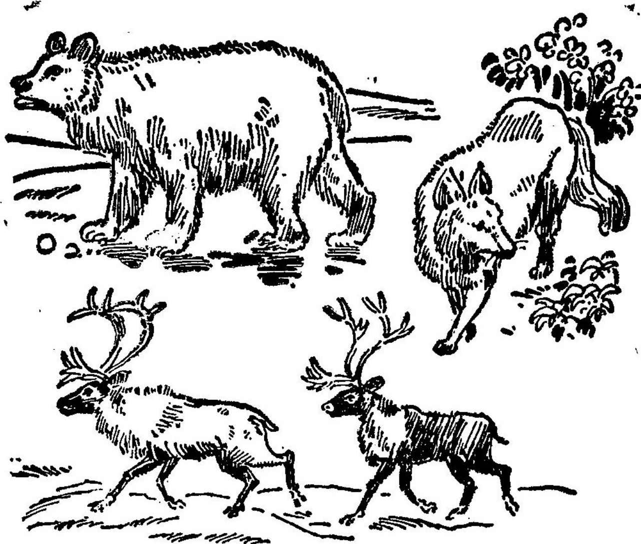


Fig. 194

Living Community in Tundra

Those animals which cannot tolerate the cold, migrate.

The feeding habits of the herbivorous animals are interesting. Caribou feed on lichens. Grass is the principal food of the muskox. Most of the small birds are seed-eaters.

These animals are not afraid of men.

Exercise

I. Questions

Answer the following in one or two sentences:

1. Name two animals that are found in the Tundra regions. Why should these animals have dense hair growth throughout their body?

2. 'The polar bear hibernates during summer' Why?

II. Fill up the blanks

1. The body of the polar bears and foxes that live in the Tundra regions have ———— as adaptations.

III. For Thought

Rearrange the following community life in the order of their productivity, starting with the most productive and ending with the least productive:

1. Desert
2. Forest
3. Tundra
4. Grassland
5. Sea

Explain, in terms of productivity, why each is put in the order you have given it.

20. VOLANT ADAPTATIONS

You may wonder how birds fly in the sky. Even though they fly far and wide, they show many adaptations for their aerial mode of existence. None of them are purely aerial because they come to the land to take rest. This type of adaptation is seen in fishes, amphibians, reptiles, birds and mammals among vertebrates. Among the invertebrates, insects are capable of flying.

Mechanism of Flight in Birds

Birds are the best fitted for this mode of life because birds have undergone the following modifications in their structure.

The Body Shape

The body is boat-shaped; it offers the least resistance for movement in air.

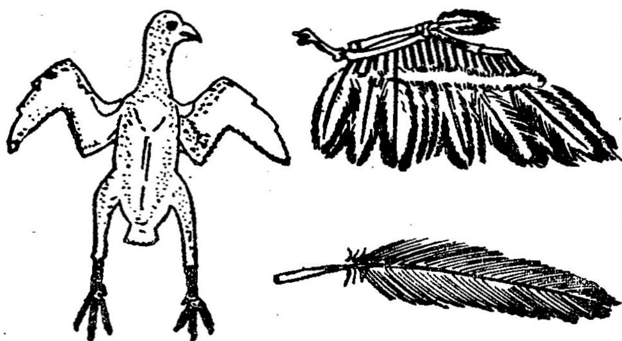


Fig. 195

External Features-Wing and Feathers of a Bird

The Wing

The wing is formed of strong muscles, nerves, blood vessels and feathers. The wing of a bird is a modified forelimb of other vertebrates. The bony framework is that of the modified forelimb.

The wings are made up of feathers. They are so arranged as to form a continuous sheath impervious to air. The flight of the birds is brought about by the upward and downward strokes of the wing. The tail feathers are helpful in changing the direction during flight.

Reduction in the Body Weight

The bones are hollow and they are filled up with air. Hence the body becomes light. The bones of the skull are almost thin. It serves to withstand the effects of varying pressures of air.

Energy for Flight

The bird requires more energy for flying. This energy is obtained by the burning of its food with oxygen. More oxygen is needed for flight. The need is satisfied by the well grown lungs and air sacs. These air sacs branch off into the body cavities. Therefore, oxygen is conveyed directly to many tissues. The warm air adds to the lifting power and aids in buoyancy. During

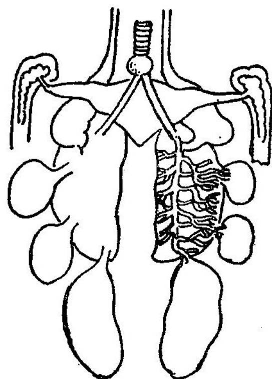


Fig. 196
Air Sacs and Lungs of a Bird

respiration, blood is oxygenated twice and this results in a high rate of metabolism. Thus birds are provided with larger amount of energy which is essential for long and sustained flight.

Eye sight of Birds

The eyes are well developed. The eyes are protected against the pressure of air currents. The eyes of the birds work independently of each other so that the bird has command over two large separate visual fields. The focus can be altered from a distant object to a nearer one almost instantaneously as an American naturalist puts it, "in a fraction of time, the eye can change itself from a telescope to a microscope"

Mechanism of Flight in Bats

Bats are the only mammals that are capable of flying as birds. They fly forward due to the up and down movements of the wings.



Fig. 197
Bat

Mechanism of Flight in Insects

The wings of insects are thin folds of exoskeletal cuticle The wings are supported by the veins or

nerves. The movements of the wings are controlled by the well developed muscles present in the thorax.

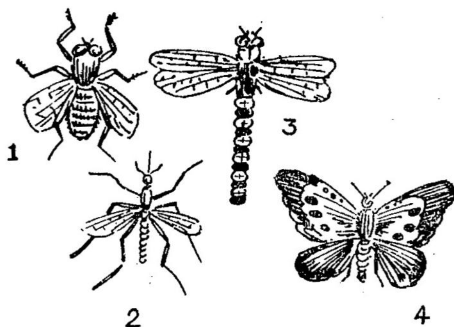


Fig. 198
Insects
1. Housefly 2. Mosquito 3. Dragonfly 4. Butterfly

Thus we find birds and insects are adapted to swim in air.

Exercise

I. Questions

Answer the following in one or two sentences:

1. 'In order to fly in air, the weight of the body of the birds is reduced' - Write two such adaptations which help the body of the bird become light.

2. How are lungs and air sacs useful to birds for flight?

3. Write the opinion of the scientist about the eyes of the birds.

4. Write the name of a mammal which is capable of flying in air.

II. Describe briefly the salient features of birds for Volant adaptations.

III. **Fill in the blanks**

The adaptations of birds

(a) The body of the bird is ————.

(b) The forelimb of the bird is modified as ————

(c) The tail of the bird is used as ————.

(d) The bones of the birds are ————

(e) The lungs are provided with ————.

21. POPULATION AND FOOD

Plants and animals reproduce in large numbers in this world. The reproduction of plants depends upon the fertility of the soil and the availability of water. They should also get enough sunlight or otherwise the plants cannot grow.

The fruits and seeds of the plant are dispersed over a large area. There are agencies for the dispersal of seeds. They are wind, animals and water.

You would have observed the seeds of calotropis being carried away by the wind. If all the seeds of calotropis grow into new plants and give out flowers and seeds. Within one or two years, you will find calotropis everywhere.

Let us take another example.

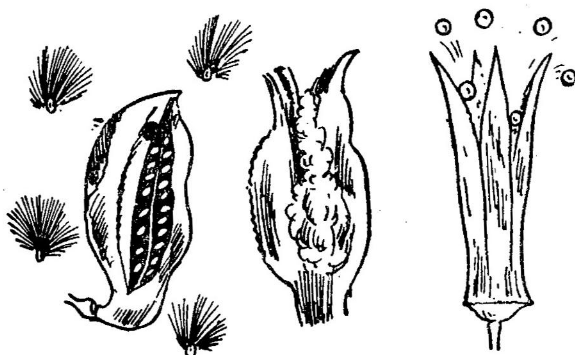


Fig. 199

Dispersal of Seeds

Observe the lady's finger plants in your garden. Do you know how many fruits are there in one plant? Each fruit will contain more than 70 seeds. A lady's finger plant may produce about 1000 seeds or even more. If all the seeds germinate into new plants, the whole world will be filled only with lady's finger plants within two years. But this does not take place in nature due to various factors.

They may be explained as follows:

1. You have studied that there are animals which live on the food prepared by the

plants. Therefore the reproduction of plants is controlled by the herbivorous animals.

2. There is also another reason why all the seeds do not grow into new plants. A seed, if it grows into a new plant, needs sufficient space; it needs nutrient water from the soil. If all the seeds of the plant fall under the feet of the mother plant and begin to grow, there will be competition in their growth.

3. Only such of those plants which are capable of getting sufficient space and water alone will survive; others will die.

4. Moreover, the growth of the plants is affected by floods and arid conditions in the land.

So far you have studied about the reproduction in plants. Let us now study about the reproduction in animals.

Animals also reproduce without any limit. A female fly lays 150 eggs at a time. If all the eggs become flies and if these flies begin to reproduce in the same manner, there will be innumerable flies and eggs. The birds and fishes reproduce in large numbers.

What will happen if all these animals survive?

In nature, if the number of animals and plants in a community is not controlled, there would be scarcity of food; there would be lack of living space.

If such things happen, the animals will have to migrate to different convenient places.

Let us now study the problem relating to the over population of human beings.

Man also reproduces in the same manner as plants and animals do. Suppose a set of parents

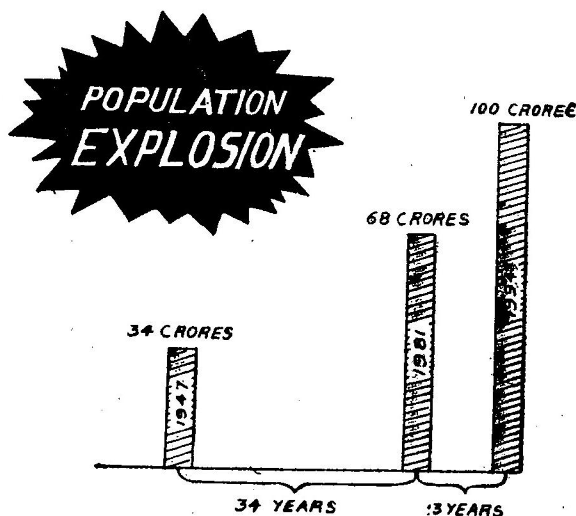


Fig. 200

bring forth five children and if these five children reproduce like their parents, in the next generation there would be 25 children. If these 25 children grow and reproduce at the same rate, there will be 125 children in the next generation. If the birth rate increases generation after generation, population will natuarally be on the increase.

Recently a survey was conducted and it was found that the population of India has grown double

since independence. The over population of human beings is a problem which causes greater anxiety today.

Effects of Population Explosion

Knowing what goes on in nature, can you suggest what would happen to mankind in the next four or five decades if the population growth continues

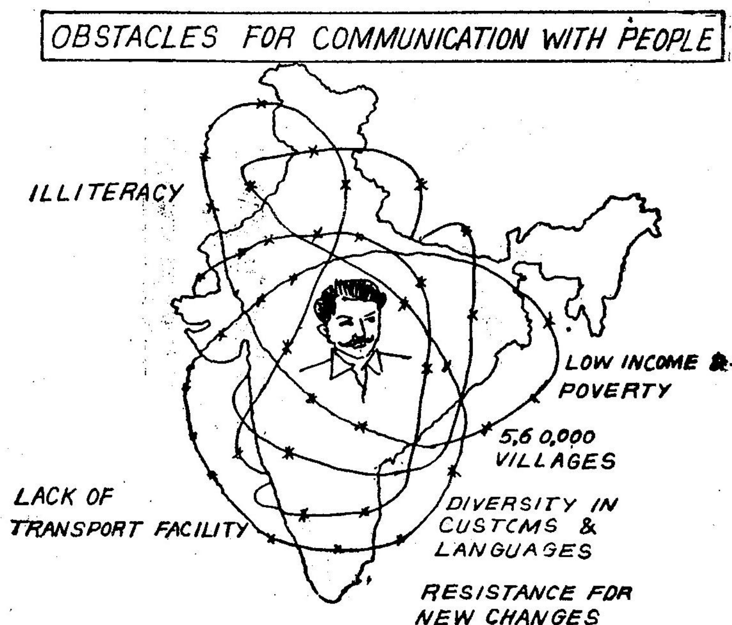


Fig. 201

at this rate and the amount of food production does not increase proportionately? The answer would be an unpleasant one.

Famine, malnutrition, spread of disease, unemployment, conflicts between nations and people with people will be the net result.

Solutions to the Problem

How can you solve the problems mentioned above?

The first thing that we should do is, to make sure that every citizen understands what the problems are. We should also make them understand the urgency for finding out solutions to the problems.

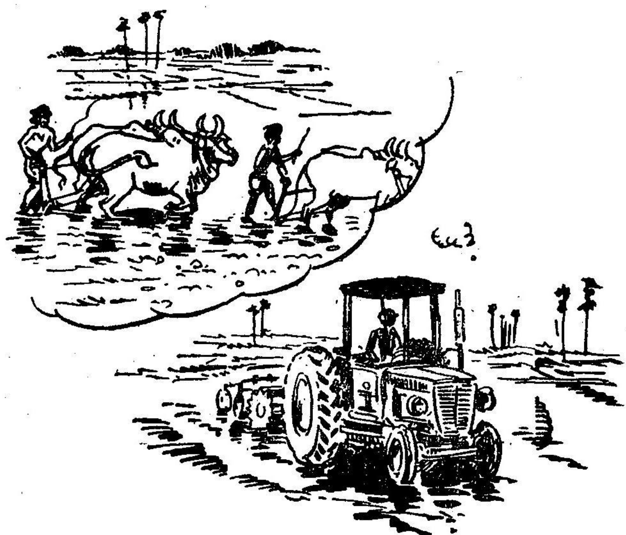


Fig. 202

The first solution is **to grow more food.** As stated already, the population of India has increased double since independence. Can we double the food pro-

duction at the same rate? How can it be done? We have to bring agricultural technology for growing more food. We must work with fertilizers; genetically improved crop plants, new high yielding crops should be developed. Many agricultural colleges in India have crossed the varieties and have produced better quality rice. Some of the varieties are Ponni, IR 8, IR 20, Kannagi, etc.

On an Indian farm, a wooden plough with a metal strip is used to scratch a furrow an inch deep. This furrow is usually pulled by oxen. The driver holds the pole in one hand and guides the oxen using the other hand. This method is not acceptable. A tractor might be used to plough the land.

Another approach to increase productivity that will support our population explosion is to exploit farming in the tropics. At present only 8% of the earth's surface is cultivated. Of these 60% of food materials is produced in the cool temperate climates. The tropics could yield more food than at present. Though many improvements have been made in the field of agriculture, crops are grown in the tropics in the same way that they were grown about 2000 years ago.

So far we studied many ways to grow food. These include growing more crops, growing better and bigger crops, converting tropics for growing crops etc.

Those of you who live in the city of Madras will know how the city is thickly populated. You

know the rush hour traffic in the trains and buses, the crowded schools etc. Many families are crowded in a single house. Therefore, the food production should satisfy the needs of the population. This is one side of the picture.

Death Rate

In olden days diseases like plague, cholera, small pox etc. and famine and floods affected mankind. Therefore death rate was very high. But recently diseases have been successfully eradicated by preventive methods like vaccination, inoculation, etc.

People now observe the health rules and therefore the death rate has been considerably reduced.

Birth Rate and Death Rate

From the above said paragraphs, it will be clear that the death rate decreases due to advancement of medical science but at the same time, the birth rate is going on increasing year after year. Hence the problem.

Malnutrition

Due to increase of population, the price of the foodstuffs is also increasing. The poor people are unable to purchase the foodstuffs. An average Indian citizen should consume foodstuffs to enable him to get 2400 calories daily. But they are unable to get the required calories of the foodstuffs. Many poor people starve due to malnutrition and therefore they are subjected to many diseases.

Calories alone are not important. There must be reasonable balance of different food constituents

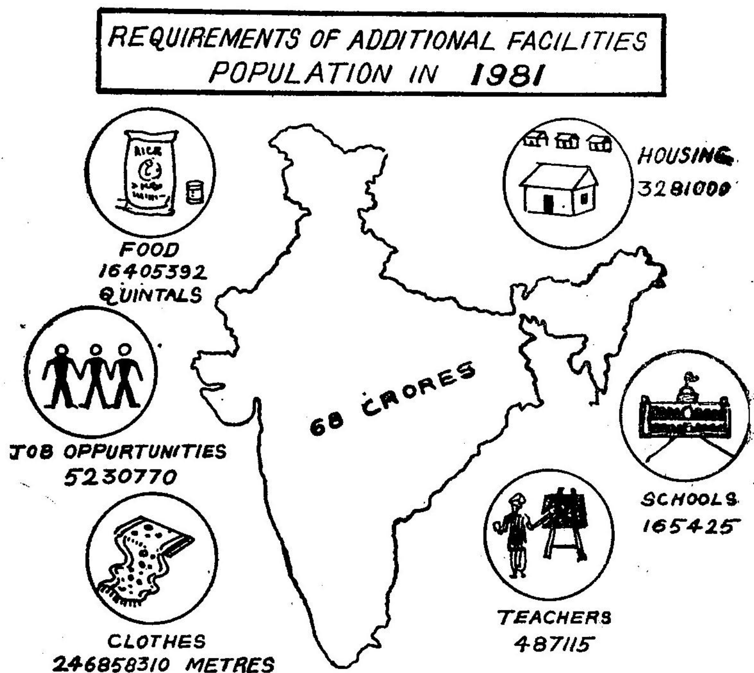


Fig. 203

such as carbohydrates, fats, minerals, proteins and vitamins.

A large amount of protein available in India remains unused. The seas contain fish but there is a segment of population in India which refuses to use these sources of energy as their food. The reason is mainly because of religion and custom. But proteins are needed for good health. Therefore, more vegeta bles which yield protein stuffs should be grown

It is estimated that 15% of the world's population suffers from malnutrition. Some people exist entirely on carbohydrates; this produces skinsores, bloated bellies, swollen limbs and feeble minds. Such people will not be useful for the welfare of the nation.

Struggle for Existence

People living in villages are coming to the city or town to seek employment because the wages that they earn for the work in the fields are low. This is also one of the reasons why the city is thickly populated.

When there is struggle for existence due to unemployment, they resort to anti-social activities. Disorderly behaviour, stealing another man's property etc. have become common.

Family Planning

Family planning is the surest and the best solution to check the population growth.

In India, family planning centres have been established throughout the country. Proper family planning will solve many of the problems of population explosion.

Today in a welfare state like ours, the government is coming forward to provide medical aid, education and transport facilities.

Lot of planning is needed to solve the population explosion problem. Planning could not be done

without taking into account the population of a country.

Exercise

I. Questions

Answer the following questions in one or two sentences:

1. What are the factors upon which the reproduction of plants depend?

2. How are the seeds and fruits of a plant dispersed over a large area?

3. What will happen if all the seeds of a lady's finger plant fall under the feet of mother plant and germinate?

4. What is population explosion?

5. What is the effect of population explosion?

6. Death rate has been considerably reduced. How?

7. What preventive methods have been used to eradicate infectious diseases?

8. What are the evil effects of poverty?

9. What is the surest solution to check the population growth?

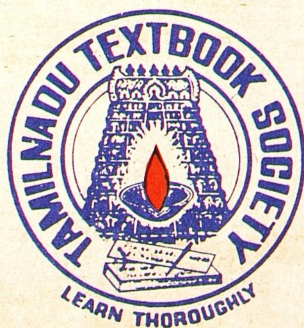
II. Answer in a Paragraph

1. How is the number of animals and plants in a community controlled?

2. What would be the effect of increase of population?

3. Planning of the country's resources can be done only by taking into account the population of the country. Is the statement right? Explain.

4. Narrate the steps taken by the government to grow more food.



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